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MONOGRAPH

OF THE

BRITISH APHIDES.

VOL. I.

BY

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"'Ο ἐξουδενῶν τὰ ὀλίγα κατὰ μικρον πεσεῖται."—Σοφία Σειράχ, xix, 1 (LXX).

"Sed . . . miramur . . . tigrium rapinas, leonum jubas, cum rerum natura nusquam magis quam in minimis tota sit."—PLINY, *Nat. Hist.*, xi, 2.

LONDON:
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MDCCCLXXVI.

TO

THOMAS BELL, Esq., F.R.S.,

WHOSE KINDLY SPIRIT AND SYMPATHISING AID FOSTERED IN THE EARLY LIFE OF THE AUTHOR A LOVE OF

NATURAL SCIENCE,

AND WHOSE

FRIENDSHIP OF MORE THAN FORTY YEARS HAS AFFORDED HIM UNMIXED PLEASURE,

THIS MONOGRAPH

OF THE

BRITISH APHIDES

Is Affectionately Dedicated

BY THE AUTHOR.

PREFACE.

When the subject of the British Aphides was pressed on the attention of the Author by an old friend and competent Entomologist, it was believed that what had to be said could be comprised in a small compass; but materials have accumulated, and the anticipated single volume has considerably swelled its dimensions. Notwithstanding this expansion, the Author has a lively sense of his omissions and shortcomings.

Like that of the Bee and the Ant, the history and the economy of Aphis is elaborate. Individual species for several months demand attention, if their development and life-history is to be at all adequately considered, and to do this well, a single group, like that of the underground Aphides, should be taken in hand at one time.

Though this present work cannot pretend to take an exhaustive view of this special department of Entomology, it has been thought better to make immediate use of such material as has been collected, rather than defer to an indefinite time a more complete history.

By a constant use of the camera lucida, and by employing living insects only for figuring, it is believed that trustworthy outlines have been obtained. Whilst, however, the camera lucida has the advantage of showing the insect in a life-like attitude, it has also the drawback of rendering the figure measurements

more difficult, on account of the unequal foreshortening of the limbs, &c.

This disadvantage has been partly obviated by the addition to the text of micrometrical measurements, which are given in thousandths of an inch, and for the use of those who employ the metric scale reductions into parts of a millemètre have been made. A reference to these measurements will prevent a wrong impression as to the relative size of certain specimens, for slightly different magnifying powers have necessarily been employed in the figures. Had it not been so, some forms in the winged state would have occupied the greater part of a page.

For rendering the insects sufficiently stationary for drawing under the camera, they were generally first stupefied with vapour of chloroform, or, what was found to be equally efficacious, with the vapour of light petroleum oil. At other times good positions of the limbs were obtained by attaching the live insect to the middlemost of three minute spots of Canada balsam dotted on a slip of glass. By means of a fine bristle, the wings were laid out and secured in their places by attachments to the remaining outer spots of balsam. This method permitted the insects to be permanently mounted for the microscope after the drawings were finished.

The Author wishes here freely to acknowledge the help he has obtained from a goodly list of both present and by-gone workers. In most places references to the various authorities have been given in the footnotes. The author has gained much information as to the life-history of the group from the treatises of Bonnet, De Geer, Kaltenbach, Koch, and Passerini.

The writings of Morren, Huxley, Balbiani, and others, have been very suggestive, and have furnished valuable materials for treating on the subjects of morphology and reproduction. It is purposed briefly to discuss these subjects in a subsequent volume.

The Author cordially thanks those numerous friends who have personally assisted him in procuring specimens for description. Had they not done so, many species of Aphides never might have come under his notice. Particularly he would mention the names of the late Mr. Francis Walker, of the British Museum, whose knowledge of species was large, and whose aid was always generously proffered; of Mr. Charles Barrett, who kindly put himself to much trouble in forwarding specimens from different parts of England; and also to Mr. Thomas Hardy, the Naturalist of the Cheviot.

Thanks are also given to Mr. W. Wilson Saunders, to Sir John Lubbock, Bart., and to Mr. Alfred Smee. Finally, the Author feels himself under great obligation to Professor Rupert Jones and the Rev. T. Wiltshire, for their friendly and searching criticism of the proof sheets, and for their assistance in passing the volume through the press. Once more he would notice the attention paid by Mr. George Standish in successfully completing the tedious operation of colouring the numerous lithographic plates.

The present Monograph in no way pretends to include all the species of Aphides which inhabit Great Britain; it really includes those only which have come alive under the Author's observation. Where he has failed to procure species known to others, he asks indulgence, on account of the comparatively sedentary life to which circumstances have consigned him.

WEYCOMBE, HASLEMERE;
October, 1876.

BRITISH APHIDES.

INTRODUCTION.

THROUGHOUT the entire class of Insects, probably no single family has had more attention bestowed upon it than the family of APHIDES or Plant-lice. The last century produced many inquirers into their economy; their writings provoked much discussion, and their discoveries in this special field of Entomology raised important questions, which even now acute anatomists and students of morphology have not wholly been able to set at rest.

The superficial observer often has a tendency to connect the importance of a subject with characters that most directly appeal to our senses, such as mere extension or size, forgetting that perhaps our ideas are lost as completely in the contemplation of the infinitely little as in the attempt to realize the thought of the infinitely great. The energies and phenomena contained within the ultimate cell no one yet knows, and possibly here cannot know.

Bacon says, "Man, the servant and interpreter of nature, can only understand and act in proportion as he observes or contemplates the order of nature; more he can neither know nor do."* Again, the same philosopher

* Bacon's words are—"Naturæ minister et interpres tantum facit et intelligit quantum de naturæ ordine se vel mente observaverit. Nec amplius scit aut potest," &c.—*Novum organon scientiarum.*

says, "The productions of the mind and hands seem exceedingly numerous in books and works, yet all this variety arises from the particular subtilising upon and applying a few known things, &c."

Searchers into the secrets of nature have acknowledged the wisdom of not neglecting the import of small things, for who shall gauge the possible scope of their action in nature's operations?

The remark is almost trite, that the history of a country is but poorly represented by recounting its wars of offence and defence, thus setting forth, almost exclusively, what may be called the barbarian successes of its inhabitants. The additional exposition of the development of its political and social laws better entitles such a treatise to the name of history, but even here the labour is incomplete, unless the development of science, under the capacities of its people, is duly set-forth, and the secrets of their wellbeing traced to the scientific energy of its members, whose originality of thought has enabled them to keep in the van of nations. Thus they prove the truth of the aphorism that "knowledge is strength."

To the economist the study of Entomology can hardly stand second in importance. These latter years have furnished us with examples of the extraordinary development and migration of insects of almost microscopic dimensions. Some kinds have marched thousands of miles in the course of a few years, and threatened the food of whole countries. Did not science show that natural checks after a time arise to restore the balance of life, we might well fear famine from the attacks of such minute insect pests as infest the wheat, the potato, and the vine.

It is now more than one hundred and thirty years since Reaumer, and subsequently Charles Bonnet, began observing Aphides. Some might think that the facts to be obtained from such insects might soon be investigated, and that the well of inquiry in this direction would soon be fathomed. To disprove such

ideas, we have only to turn to the mass of literature which relates to this subject, and notice how it embodies the labour of some of the most acute natural philosophers of almost every civilised country.

The cause of this interest may be traced without difficulty to two principal facts. In the first place, the study of these creatures has presented to the embryologist questions for solution of the greatest importance. Phenomena connected with processes of reproduction occur, which even now some physiologists consider to be abnormal, and concerning the interpretation of which unqualified consent is by no means accorded.

In the second place, the general naturalist has found much to engage his earnest attention, whether he regards the varied life-history of the different species of Aphides, their curious habitations, the injuries they inflict on vegetation, or the defences they make against the host of insect foes which attack them on all sides—attacks which keep within limits an extraordinary fecundity, which otherwise might bring famine into the districts they infest.

Professor Huxley quotes the following words of the enthusiastic savant Duvau :—" J'ai souvent pensé qu'on pourrait dans l'histoire des sciences désigner les époques par les principales découvertes. Par exemple, 1665 serait l'époque de la Gravitation, 1789 l'époque de la méthode naturelle en Botanique, et, *si parva licet componere magnis*, les années 1740 à 1750 seraient l'époque des Pucerons."

After such opinions no apology will be needed for setting forth those discoveries and ascertained facts which are connected with this division of the HEMIPTERA HOMOPTERA.

Before entering upon the general history of the British APHIDES, it may not be considered out of place to devote a few remarks to the obscure etymology of the word *Aphis*.

ETYMOLOGY OF APHIS.

Although we have no certain evidence to show that Aristotle or any of the Greek naturalists paid attention to APHIDES, the word *Aphis* distinctly points to a Greek origin. I believe the word cannot be found in classical Greek or Latin. Virgil even, whilst describing *rubigo* in the Georgics,* the effects of blasting mildew on the grain, and the "unbidden crew of graceless guests" which choke the fields, appears to make little or no allusion to the host of insect pests and creeping blights which, doubtless, in his day, as now, disheartened the cultivator of the Italian plains. At any rate, Virgil gives us no description by which we may identify the *Aphis* or plant-louse.

The great Linnæus did not overlook these minute creatures in his 'Systema Naturæ,' in which work he makes the first step towards classification on a good basis. There can be little doubt that, in giving the name *Aphis* to this family of insects, he intended to suggest some peculiarity in its economy; yet now it is not easy to say what quality he wished to imply by the term.

Probably Linnæus coined the word, with reference to the office of the unique organs known as the nectaries or cornicles, which exude and sometimes project the so-called "honey-dew," or sweet secretion elaborated by Aphides from the juice of leaves.

Although alive to the difficulty of the occurrence of the δ in the plural *Aphides*, the author suggests a derivation from the verb ἀφιημι, in the sense *emitto*.

To a writer in 'Notes and Queries,'† who singularly is the author's namesake, he is indebted for the remark: "the word *Aphis*, like some other *quasi* classical words imported into science, is not certain as to its derivation. It appears probable that it may have

* Georgics, 1, verse 151, *et seq.*

† 'Notes and Queries,' vol. vi, p. 140, ser. 3rd.

been introduced from the Greek, ἁ and φὺς, unbegotten, in reference to the parthenogenesis of the APHIDES But the plural APHIDES could not arise until ἀφυς had been corrupted into ἀφις, and then it followed the analogy of ἀκρις ἀκρῐδος, &c."

A friend remarks that ἀφυς should make the substantive ἀφυα, which word already exists as a genus in the system of some ichthyologists. He further suggests ἀφή (ἅπτομαι), pointing to the close contact or crowding of the insects on the leaves or stems of plants. Etymologically we have an exact analogy in (ῥαφη,) ῥαφις—ῐδος from ῥαπτω.

The loss of the breathing in ἅπτομαι, perhaps, is not a serious objection.

Another friend points out the word Ἀφυω, *exhaurio*, from ἀφυσσω, *haurio*, in reference to the suctorial habit of the family.

Yet again another solution has been offered, but some may think it rather remote, viz. α and φείδομαι. The classical adjective ἀφειδὴς is known, and to it may be given the sense "unsparing," which might refer to the voracity of some species.

But if here we account for the δ, we introduce the difficulty attending the shortening of the long syllable, in mitigation of which, however, we have πῐθανος, from πείθω, and in Latin we leave *fĭdes* from *fīdo*, &c.

With these remarks I must leave the derivation and meaning of the word *Aphis* to such adept philologists as may care to rescue it from its seeming barbarism.

It may here be mentioned, that the phtheir (φθεὶρ, *pediculus*) of the ancient Greeks has been identified by Planchon with *Dactylopius longispinus*, Jarg, which is a true *coccus* or bark-louse, and is still to be met with in the Crimea.*

* See C. V. Riley on 'Noxious and Beneficial Insects in the State of Missouri,' 1872.

HISTORY OF BRITISH APHIDES.

This may be conveniently arranged under the following heads—

1st. A Terminology which includes the general anatomy.

2nd. A Bibliography containing a résumé of the most noticeable work of the early authors.

3rd. A Life-history, which includes the Metamorphosis of Aphides, supplemented by a brief statement of the views of more recent investigators, with reference to their reproductive economy.

4th. A Diagnosis of such species as have come under my notice in a living state, each species being illustrated by coloured figures representing the larval, pupal, alate, and, when possible, the sexual forms.

5th. A Description of the principal organs connected with the reproduction of Aphides, coupled with short remarks upon the morphology of the family.

When we consider that during the last century and a half, both French and German naturalists have described the Aphides of their respective countries, it is a little remarkable, how small has been the activity of our own entomologists in this direction. Many workers have, doubtless, been deterred by the confusion into which this group has fallen with reference to its synonymy—a confusion partly caused by the want of good figures, and partly by the impossibility of preserving type-specimens of the insects in a condition fit for comparison. A further confusion of names has also arisen, from acting on a suggestion, first thrown out by the great Linnæus, that each species of plant possesses its own peculiar *Aphis*—an idea in a manner confirmed by him, when he made the specific names of those *Aphides* he knew coincide with the names of the plants on which they fed.

Reaumer's words, as quoted by Bonnet, lead to the same conclusion, though there is some reservation made.

He says, " Leur nombre n'est peut-être pas inférieur à celui des espèces des plantes; car s'il n'est pas sûr que chaque espèce de plante ait son espèce particulière de Puceron, il est certain seulement qu'en général des plantes de différentes espèces ont différentes espèces de Puceron, et que souvent plusieurs sortes de Puceron aiment la même plante."

Neglect of this last observation will partly explain the fact, that one species of *Aphis* possesses no less than thirty synonyms, and again, that the same name has been given by authors to six different species of *Aphis*.

Kaltenbach also says, that observers have been deterred from a study of the family from an erroneous notion of the multiplicity of its species. Thus Schmidberger recently estimated the number at upwards of one thousand, which doubtless is largely in excess.

The distinctive characters of APHIDES are far less marked than those of most other insects. Colour, which appeals so forcibly to the eye in the LEPIDOPTERA and other groups, is here but an insufficient guide. The young of some species are quite unlike their parents in this respect, and their hues vary even in the course of a few hours. Again, the adult insects sometimes change their prevailing tint, simply through a reduction of temperature, at which time they may go through all the changing shades of the autumn leaves amongst which they nestle.

When to these difficulties the fact is added, that some APHIDES show a certain inconstancy of both size and colour; which may be caused by variations in the kind of food-plant infested, some indulgence is craved if, in the present Monograph, failure hereafter may be shown, as to the identification of some British with Continental forms.

The family of APHIDES is comprised in the second large division *Haustellata* of the class *Insecta*. It further belongs to the order HEMIPTERA (Rhynchota of Burmeister), which, again, is separated into the sub-

orders Heteroptera and Homoptera. Aphides pertain to this latter group, inasmuch as, of the four membranaceous wings which they possess, the two upper want the semicoriaceous portions which distinguish the wings of the Hemiptera proper.

Although Linnæus places Aphides between the Cimicidæ and Chermesidæ in his system, they seem to be more closely connected with the Coccidæ on the one side, and the Psyllidæ on the other. They also hold many characters in common with the more distantly related Cicadiidæ or froghoppers. Aphides differ, however, from the Coccidæ in being of a more active habit, and from the Cicadidæ in being quite incapable of leaping, and possessing besides antennæ of a different character. By these last attributes also, they may be distinguished from the Psyllidæ or leaping plant-lice.

Perhaps of all insects in this group, the Aphides are the most difficult to describe. Linnæus says, before giving his remarks on the thirty-three species which came under his notice, "Species difficile distinguntur, difficilius definiuntur, nec semper in diversis plantis diversæ species, adeoque pauciores mihi aphides quam plantæ aphidiferæ."

Thanks to the labours of Burmeister, von Heyden, Kaltenbach, Koch, and Passerini, the family now has been cut up into genera, with more or less success; which procedure has much facilitated its study.

Without closely following these three last systematic authors, an endeavour has been made rather to harmonise their schemes, which have so much in common, than to introduce confusion into a subject, already sufficiently intricate.

Partly for this reason, neither the classification so elaborately set forth by Signoret in his regrouping of the Rhynchota, nor the system of Schiödte, which is founded upon the form and rotation of the coxæ, has been adopted.* Difficulties, it must be confessed, as to the true natural classification of Aphides still remain.

* Signoret, 'An. Soc. Ent. de France,' 4e sér., t. ix, pp. 549–596.

These may vanish when we possess more complete knowledge of those rare male and female oviparous forms which close the cycles of the various species.

The following synopsis is appended, to set forth the general relations of the APHIDES to other families of the class Insecta.

The Aphides have the following family synonyms:

Aphides, Linnæus.
Aphidæ, Curtis, Westwood.
Aphidina, Burmeister, Walker, Hartig.
Aphidinæ, Rondani.
Aphididæ, Passerini.

- Class. INSECTA.
  - Sub-classes.
    - Mandibulata.
      - Orders.
        - Coleoptera.
        - Orthoptera.
        - Neuroptera.
        - Hymenoptera.
    - Haustellata.
      - Orders.
        - Lepidoptera.
        - Diptera.
        - Hemiptera (Rhynchota).
          - Sub-orders.
            - Heteroptera.
              - Families.
                - Cimicidæ.
                - Pentatomidæ.
                - Coreidæ.
                - Reduviidæ.
                - Acanthiidæ.
                - Hydrometridæ.
                - Nepidæ.
                - Notonectidæ.
            - Homoptera.
              - Families.
                - Cicadiidæ.
                - Cercopidæ.
                - Thripidæ.
                - Psyllidæ.
                - Aphididæ.
                - Coccidæ.

It would be premature here to discuss the question, as to what really constitutes the *individual* in such an exceptional group as *Aphis*. In a general way it may be assumed, that development proceeds from the egg to the imago through several metamorphic phases.

The immediate products of the eggs are active six-footed larvæ, which, in the individualisation of the subsequent generations, undergo slight modifications at the times of their various moultings. Eventually six-footed active pupæ appear, which finally become winged imagos.

These alate forms show most of the characteristics of the original larvæ. Thus their antennæ, legs, siphuncles, and rostra are similarly constructed. Consequently, in the system based on the nature of the metamorphoses of insects, and the terminology of Professor Westwood, Aphides are ranged under the comprehensive head Homomorpha.

§ I. TERMINOLOGY.

(A) THE EXOSKELETON.

APHIDES show in their larval condition many resemblances to both the Coccidæ and the Cicadidæ. Like them, they possess soft yielding bodies, which are capable of considerable distension. When contracted by the partial loss of their juices, the skins of these bodies are thrown into more or less marked folds or corrugations.

The general aspect of *Aphis* may be described thus:—Body soft and yielding; usually globose or oval, rarely linear. The bodies of the larvæ are often heavy and inflated, and disproportioned to the size of the legs. The exterior integument or exoskeleton has but little rigidity, and does not show the dense coriaceous texture seen in most insects. APHIDES, therefore, exhibit but little muscular activity, and except by stratagem are almost defenceless against their numerous enemies.

The body is divided into rings or somites, but much discussion has arisen as to the normal number; indeed, the number is inconstant. In some species certain rings are either hidden, or entirely suppressed.

At the posterior end, mostly, but not always, two remarkable ducts occur, which generally project above the surface of the back. These are the well-known cornicles, nectaries, or siphuncles.

A suctorial beak is folded on the breast, through which the insect pumps up the juices of the leaves, roots, or stems, of the various plants which form its nourishment.

Although the family shows a great diversity in tints and markings, neither characteristics are of so constant

and definite a nature as we find in the Hemiptera Heteroptera.

The body is divided into three greater divisions, viz. the head, the thorax, and abdomen.

THE HEAD

comprises the face, the vertex or crown (which is either pointed, convex, or flat), the rostrum, the two compound eyes, and the ocelli. In Siphonophora and like genera, two thick frontal tubercles rise from the vertex, near the upper margin of the compound eyes. These basal tubercles sometimes present peculiar gibbous or dentate characters. As they are immovably articulated to the head, they must not be confounded with the antennæ joints, which are seated upon them.

THE ANTENNÆ

are of various shapes and lengths, and differ in the number of their component joints. These joints furnish reliable characters for constructing the genera.

In Aphis proper there are seven joints. In Pemphigus and Schizoneura there are six joints, and in Phylloxera the number of joints is reduced simply to three. It is important to refer to the adult insect for these details, since considerable discrepancy often occurs in the larval forms. These discrepancies slowly disappear from the insect, as it passes from moult to moult. The normal number may not even be found in the pupa. This fact has been overlooked by some early authors, and has accordingly produced confusion in their descriptions.

The abnormal number of antennæ joints often may be seen on comparing the imago with the pupal and larval conditions of the subterranean Aphides.

The terminal joints of the antennæ afford good dis-

criminating characters. In Siphonophora and like genera the seventh and last joint is very long, and often imbricated.

In the Lachninæ, the seventh joint, although obvious, is much curtailed in length, and here it shows the first tendency to abort. In the Chermesinæ this joint so far disappears that it is represented by a mere nail or wart-like appendage; and, as this last portion shows no articulation, it has been ignored by Kaltenbach and others, who regard this genus as possessing five joints only. To the question whether or not this appendage is to be regarded as a little joint, must be referred the different diagnoses of identical genera, as given by Koch, Passerini, and others. The first and second joints of the antennæ in the whole family of Aphides are shorter, rounder, and thicker than those which follow. The first is either articulated directly to the head, or else, as before stated, it is placed on the frontal tubercle. The third joint is almost always the longest, and has often peculiar characters attached to it. Thus the alate males and viviparious winged females often show it plentifully studded with circular, or irregular, hollow tubercles, the outer rims of which appear to be connected with delicate membranes, which are drawn, like those of a drum, over the mouths.* If the views of Newport and others are correct in ascribing to the antennæ some function connected with a sense analogous to hearing, it is here suggested, that these membranes may vibrate to waves of sound, and probably have an action similar to the membranous organs known to exist at the bases of the antennæ of some Blattidæ and Gryllidæ. The sense of hearing has been proved to be acute in both these families.

The winged males of APHIDES have longer antennæ than the winged viviparous and apterous females of the same species. Possibly their more active and roving

* The reader is referred to the first three plates, A, B, and C, for illustrating this and other like details in anatomy.

habits create wants which are supplied by these more highly developed organs.

The hard basal joints of the antennæ are attached to the head, or to the frontal tubercles, by a supple membrane, which permits the freest play. Some species keep their antennæ in more or less continuous vibration.

In Schizoneura and allied genera, the joints of the antennæ are elegantly formed of cup-like bodies, which are inserted one within another. In other forms a ringed character may be detected (*vide* Plate A, fig. 7).

It is not difficult to trace in some transparent species a fine nervous filament which traverses the whole length of the antennæ. It proceeds from a plexus of nerves situated near the base of the rostrum, in the centre of the head. This filament is compound on leaving the plexus, but appears to become single on entering the antenna, or more probably from the place they enter they are enclosed in one common sheath. Possibly these nerves may be cognizant of vibrations transmitted through the fluids which bathe the interior of these organs.

The antennæ vary much in length. In some genera they scarcely equal in length the breadth of the head; in other genera they may reach to the base of the abdomen, whilst in Siphonophora and Callipterus they have their full development, and often very much exceed the length of the body.

THE EYES.

Aphides, with the exception of some of the root-feeding species, are very completely furnished with these organs. They appear in the embryo at an early stage, and then may often be seen to dot the transparent skin of their mothers, as brilliant red spots.

The large compound eyes are constructed much after the plan seen in the Diptera and Hymenoptera, but it will be noticed, that instead of their being facetted with

the usual polygonal lenses, these last approach the forms of hemispheres.

The colour of the eyes varies from brilliant red to brown or black. The pigment behind the choroid is, in some few species, developed into dots, which gives to the eye a uniformly spotted appearance. When the imago first issues from its pupa the eyes often appear of a bright green colour, or else they take a paler hue than that afterwards seen in the adult insect.

Latreille and Burmeister first noticed the remarkable *supplementary eye* or *tubercle* which is superposed on the cornea of each compound eye. Each of these small tubercles is furnished with from five to ten hemispherical lenses, which do not seem to differ in structure from those of the compound eyes.

It is not easy to conceive what modification of vision these smaller eyes subserve. We find them present in the winged forms, which also possess the ocelli. These last organs generally are supposed to be adapted to distant vision.

The winged insects, therefore, are provided with no less than three different kinds of eyes.

The Larvæ of some species are quite blind; others show the merest rudiments of eyes. Thus the larva of *Vacuna dryophila* possesses only an eye composed of a small tubercle, garnished with four or five lenses. Again, some subterranean APHIDES are wholly destitute of sight.

The presence of this supplementary tubercle is of no value for the discrimination of genera.

The males and winged females of all APHIDES show three, or very rarely six ocelli or *stemmata*.

They are absent in the larvæ, but sometimes may be traced as red spots, on the vertex, through the integument of the pupæ. In the imago an ocellus is placed at the inner margins of each compound eye, close to the base of the antenna. The third ocellus is on the vertex, between the antennæ, and it often gives a pointed outline to the head.

A large plexus, situated in the centre of the head, distributes a fasciculus of nerves to the base of each compound eye, and also sends forth several distinct and separate filaments to the seat of each superposed eye. From this separate distribution of nerves, it seems probable, that diverse functions belong to each variety of eye.*

Fritz Müller, of St. Catherine, Brazil, has started the question whether ocelli—or at any rate the size of the ocelli—are not connected with the nocturnal habits of insects.

Amongst the Hymenoptera he notices the crepuscular movements of some of the *Apidæ*, of the *Dorylidæ*, and a social wasp, *Apoica*, all of which are largely ocellated. The nocturnal habits of *Aphis* are not marked, yet all the winged forms possess stemmata. The rudimentary eyes of the underground species are compound, and do not show the characters of ocelli, as, from above, we might expect, if eyesight is of any advantage to them.

THE ROSTRUM, PROBOSCIS, OR HAUSTELLUM

springs from the base of the deeply sulcated and lobed *clypeus*, which last rises strongly in relief from the lower portion of the face. As in other Hemiptera, the *rostrum* is an extension of the *labium*, which is modified into a kind of sheath. This sheath is not completely perforated, but is deeply channelled on its upper surface, so as to receive three long, and exceedingly fine *setæ* or lance-like piercers. This sheath is formed of three joints or separate members, of which the first is much the longest. The second is more dilated than the first, and appears to be perforated, not channelled like the others—a modification which probably affords a better support to the setæ when in action. The third joint is short, obtusely pointed, and cleft to the apex, from which the setæ may be often seen to protrude.

* *Vide* Plate B, fig. 5.

The point is usually black, and is armed with fine hairs, perhaps employed for tentative purposes.

The three setæ are the representatives of the *mandibles* and *maxillæ* of the insect. Although the labial and maxillary palpi are wanting in *Aphis*, indications of them may be traced in certain processes existing in the immature embryo, which subsequently are suppressed.

The *labium* is well developed in such genera as Lachnus and Stomaphis. Usually it is falciform. It acts as a partial cover to the groove of the rostrum, and protects the setæ when the proboscis lies folded on the breast between the coxæ.

Aphides thus are wholly suctorial in their habits, and depend upon the sap of different plants and trees for nourishment. As the sources of their food vary, so the *rostrum* undergoes modification, to meet special requirements. Whilst some genera are furnished with exceedingly short rostra, others show this organ produced to an extraordinary length. The most marked example of this peculiarity may be noticed in *Stomaphis quercûs*, which seeks its sustenance in the alburnum of the dense trunk of the oak tree. Here the *rostrum* is nearly twice the length of the insect, and the setæ are very much longer. By these piercers the insect burrows under the hard masses of the cortex, and produces, by their irritating and inflammatory action, a plentiful flow of sap.*

The juices are drawn into the mouth by a sort of alternating or pumping motion, analogous to that seen in the proboscis of the honey-bee.

The *rostrum* is often disproportionately long in the young of some Aphides. Thus, in *Lachnus* and *Schizoneura* it projects beyond the end of the abdomen, and it is carried as if it were the tail of the insect.

An extreme development of the setæ may be noticed in the young of *Chermes laricis*. These long and delicate piercers are coiled into a spiral, which would seem to act as a kind of spring cable, by which the insect

* For a figure of this remarkable rostrum *vide* Plate B, fig. 1.

moors itself to its feeding locality. Thus it is secured from dislodgment by the rough winds of early spring.

Burmeister* pointed out a similar remarkable prolongation of the setæ in the allied family of *Coccus*.

Punctures never seem to be made by the rostral sheath. Under a lens, the leaf-feeding Aphides may be seen to search for a juicy spot with the tip of the rostrum. The piercing bristles then are inserted into the parenchyma, which would appear to be lanced in every direction by a sawing motion, which operation causes a plentiful flow of sap to the wounded part. The points of the setæ are not armed with barbs or serrations.

THE THORAX.

This is composed of three principal parts, each of which bears its corresponding pair of limbs.

The first segment, styled the *Prothorax*, *Pronotum*, or *Neck-ring*, is articulated to the head by a dense membrane, which shows itself often as a light-coloured band. This segment usually is small, and narrower than the head; but in the winged *Chermes* the *Prothorax* is so considerably developed that it nearly equals the bulk of the *Mesothorax*, and thus the insect has a somewhat overbalanced and clumsy appearance. This peculiarity is still more marked in the underside of the pupa of that species, where the coxæ of the first pair of legs are far in advance of the position pointed out by the other coxæ.

The *Prothorax* is occasionally furnished with a strong, blunt tooth, on each lateral edge, the use of which is not known.†

The *Prosternum* supports the *Fulcra*, to which the first pair of legs are articulated.

The second thoracic segment is styled the *Mesothorax*

* Kaltenbach, 'Einleitung Terminologie der Pflanzenläuse,' p. xiii.
† Plate B, figs. 3 and 4.

or *Mesonotum*. It is usually large in the winged forms, which exhibit the upper surface chiefly occupied by the *Scutum*. Here three conspicuous coriaceous lobes appear, of which the two lateral give support to the muscles of the first pair of voluminous wings. Between them, and a little in advance, a third lobe is seen, which may be the representative of the *Præscutum*.

The *Scutellum* is somewhat triangular in shape, and is placed posterior to the two lateral lobes.

The *Mesosternum* is deeply excavated, to receive the folded rostrum, and on each side the *fulcra* occur, belonging to the second pair of legs.

The third segment, called *Metathorax* or *Metanotum*, is rather inconspicuous. It supports, above, the hinder pair of wings, and below, on the *Metasternum*, are placed the fulcra for the third pair of legs.

THE ABDOMEN.

This part of the body is composed of several rings, and is capable of much distention. On this account the insect presents very different outlines, according to the varying amounts of fluid nourishment it contains. The dorsal and ventral rings are laterally united by the yielding folds of the *Connexivum*, which by its corrugations gives rise to a puckered edge or *carina*, that becomes more and more obvious as the insect shrinks by being stinted in its food. On the other hand, the insect may be so fully fed that the *Dorsum* becomes domed and shining, simply from distention.

The number of rings most easily distinguished in the abdomen is nine, but theoretically it is eleven. Perhaps the want of agreement among naturalists, as to the typical number of *Somites* in INSECTA, is caused by the discordant views entertained as to the composition of the insect head.

Whilst some would make the head but a single

somite, Professor Huxley* makes certainly five, and hypothetically six. Three are in the thorax, and, according to Newport and Westwood, there are eleven in the abdomen. This number also is ascribed to the Hemiptera Heteroptera by Messrs. Douglas and Scott.† Whilst Huxley considers that the last *somite* in Aphis is abortive, as in some other orders, like the Lepidoptera, &c., Balbiani ‡ thinks it is represented by the *Cauda*, which in some genera is an organ of considerable size.

Kaltenbach,§ in his excellent monograph, and Ratzeburg‖ also, considers that there are only nine abdominal rings in *Aphis*. More recently M. Lacaze-Duthiers, by generalising over various orders of Insecta, concludes that the different forms of stings, borers, and ovipositors are all modifications of the ninth abdominal somite. He shows that the *vulva* of insects always opens between the eighth and ninth somites, and also that, in most Hemiptera, three somites intervene between the *vulva* and the *anus*, which last orifice is always placed at the very extremity of the body. Balbiani incidentally only discusses this question, as to the segmental system of the genito-anal region of *Aphis*, but he considers that a comparison of the corresponding region of the female parts, with that of the male, leads to the conclusion, that all these parts are comprised in three abdominal segments, and therefore suggest a unity of composition, quite in harmony with the views of Lacaze-Duthiers and Professor Huxley. The last physiologist considers the *penis* to be a modification of the tenth somite. Balbiani regards the *vulva* as

* Huxley, "On the Morphology of Aphis," 'Trans. Linn. Soc.,' vol. xxii, Part 3, p. 230.

† 'Ray Soc.,' vol. for year 1865.

‡ Balbiani, "Mémoire sur la Génération des Aphides," 'Ann. des Sciences Naturelles,' 1 sér., t. xi, p. 64.

§ Kaltenbach, 'Monographie der Familien der Pflanzenlause,' 1843, p. xiv.

‖ Ratzeburg, 'Die Forst Insecten,' Berlin, 1844.

formed from the eighth, the lateral appendages ("Afterlappchen" of Kaltenbach) as the ninth, the *anus* and anal plate as the tenth, and the *cauda* as the eleventh segment, respectively.

Thus, typically, the head represents six somites. Of these, the caput proper, the antennæ, the labium, with its setæ, may be assigned to three. The other three somites are indicated by the three joints of the rostrum or haustellum. The thorax next is composed of three somites, as indicated by the *pro-*, *meso-*, and *meta-thorax* previously described. These, when added to the eleven abdominal segments, complete the typical number of twenty.*

It often happens that several abdominal rings of the larvæ are so united by their sutures that their number cannot be distinguished. This is markedly the case when the *Aphis* has been struck by an *Aphidius*, or other parasitic insect. The larva then appears much like an inflated and shining bladder, supported on six legs.

On the under side of the abdomen, generally from seven to eight rings can be distinctly counted, excluding the genito-anal region.

Below the lateral edge, formed by the *Connexivum*, the *Stomata* or apertures leading to the *tracheal* or respiratory system are placed. These occur at the sutures of the various rings, and typically should be ten in number. They are not always easily recognised, but in some light-coloured species their position may be detected by certain dark stains or punctures. The *Stomata* are always placed on the under side of the body, and appear to be of the simplest character, seemingly without fringes or opercula.

The *Stomata* present either circular or oval apertures, which are kept distended by a horny ring. Every segment has its appropriate pair, with the exception of the head. One is placed close to the base of each *cornicle*.

* *Vide* figure of a typical Aphis after Huxley, Pl. B, fig. 5.

Although these entrances to the air-passages were noticed by Bonnet, they singularly escaped the sharp observation of Léon Dufour.

The pits or depressions formed by the *connexivum* were considered by Hausmann of sufficient importance to be included in his specific characters. The young forms of some species doubtless show these pits very markedly, but as they vary by age, and even afterwards entirely disappear, I have followed Kaltenbach's example in regarding them as of minor import.

THE CORNICLES, NECTARIES, OR SIPHUNCLES.

Considerable diversity, both in form and size, is shown by these remarkable and unique adjuncts to the sixth abdominal ring.

In genera like *Siphonophora* and *Drepanosiphum* they have considerable bulk, and occasionally attain to the length of half the insect. As their shape, relative length, and colour are very generally constant in the adult insect, they are of much consequence in the diagnosis of species.

These *cornicles* or *siphuncles* are of a horny nature, and constitute the sheaths of certain excretory ducts, the delicate walls of which are often seen to traverse their interior. They rise above the surface of the back into more or less long, moveable, and erect tubes. They occur either straight, curved, skittle-shaped, or vasiform. Their mouths are often expanded into trumpet-shaped orifices, which appear to have a membrane capable of being compressed within the aperture, at will of the *Aphis*. The *nectaries* are very small in some genera, and are entirely wanting in others. Thus, in *Lachnus* these organs are mere perforated tubercles, whilst in *Phylloxera* and *Trama* they are obsolete.*

Many have been the surmises as to the special

* For these details *vide* Plates A, B, and C.

function of these organs. Even now, physiologists are not agreed as to the part they play in the economy of the insect.

Bonnet regarded them as external terminations of urinary canals; but more recently they have been connected with the respiratory system.

Charles Morren,* in his interesting and, in many respects, important memoir on the peach Aphis, considers them to be nothing more than prolonged *stomata*, and he states that a considerable lacing of tracheæ may be seen to start from the points at which the cornicles enter the integument. Further, he asserts, that the air replaces the liquid which is ejaculated from these tubes, and that the bubbles so often to be seen within their cavities are evidences of this regurgitation of air.

Morren also assigns a second function to the *Cornicles*. He points out, and figures a gland at their bases, to which he ascribes the secretion of the usually sweet and unctuous liquid, in this country known as "*honey dew*," and which he regards as the first nourishing fluid provided for the young Aphis.

Morren† puts forth, indeed, the curious idea, that there is some similarity between Aphides and Mammifers, inasmuch as he has repeatedly seen the young suck the secretion from the tips of the cornicles of their mother. He says:

"J'ai vu plusieurs fois de jeunes pucerons sucer le bout de ces cornicules, en y plongeant leur bec.

"Cela est arrivé chaque fois que je fasais accoucher des femelles dans des bocaux, sans aucune feuille de pêcher qui pouroit servir de nourriture aux jeunes et à la mère."

The belief that the above-mentioned globules within the *cornicles* are composed of air appears also to be

* Prof. Chas. Morren, "Puceron du Pêcher," 'Ann. des Sciences Nat.,' 1836.

† Idem, page 94.

held by Kaltenbach,* who thinks that probably these organs are connected with the breathing apparatus, which opens from the stomata, and that they assist in the more complete aëration of the nourishing fluids. The erect position of the cornicles, and the habit shown by some species of slowly vibrating them, confirms, he thinks, this view.

Still the question may be asked, Why are some genera of Aphides specially provided with these organs, whilst others are wholly devoid of them? Kaltenbach attempts to meet this objection in a manner which, if I rightly understand him, may be summarised thus. Starting from the position that active life-functions in the individual always stand in close relation to rapid respiration, he says—

Those Aphides which, like the genus *Siphonophora*, have several broods in the year, and those very numerous as to individuals, require the greatest amount of oxygenation of their nutritive fluid. Accordingly, their *stomata* are supplemented by long cornicles, which effect that change through their expanded mouths. This aëration, however, acts unfavourably on the life duration of these insects, for he has observed that such apterous forms rarely live beyond eight days, and that the winged insects have an existence not much extended beyond this limit.

On the other hand, it is to be noted that where, as in *Lachnus*, these organs are only represented by mere tubercles, the brood is restricted solely to one. The insect rarely changes its feeding ground, and sometimes it may be observed fixed in one spot for three months together.

Again he remarks, that some of the underground feeders, and those which hybernate in the crevices of bark, are entirely without cornicles, which circumstance, he thinks, is in accordance with their sluggish and inactive habits.

Notwithstanding the ingenuity of this explanation,

* Kaltenbach, "Monographie," 'Einleitung,' p. xv.

which assigns to these siphuncles the task of rapidly aërating the circulating juices, I believe the theory breaks down under the following facts. No anatomist has yet shown any real connection between the *tracheæ* and the tube of the cornicle. Morren, it is true, gives a figure to show the lacing of the tracheæ or air-vessels close to the base of the cornicle, but he found no anastomosis whatever with the siphuncular canal. I have repeatedly myself sought for such a communication, but without success.

Again, as the sixth abdominal ring has its own pair of stomata placed in the immediate vicinity of the cornicles, it is not likely that both these apertures should have the same function.

Once more, it is a little remarkable, that the highly refractive oil-like globules seen within the cavities of the cornicles should have been mistaken by authors for air-bubbles. These globules may be readily expressed from the tubes, when their true nature becomes obvious (*vide* Plate B, fig. 6; Plate A, figs. 15, 16). The cornicles must be regarded as the external terminations of excretory ducts, which do not permit the regurgitation or recession of air into the body of the Aphis.

THE CAUDA OR TAIL.

The presence or absence of this adjunct to the abdomen gives a good distinctive character, and affords material help in cutting up into sections such extensive genera as Aphis proper, as now restricted. The *Cauda* occurs in various forms—*clavate*, *acuminate*, *recurved*, and *ensiform*. It is exserted from the ninth abdominal ring, immediately above the anal plate, between which and itself the anus is situated. Occasionally it has an imbricated exterior, and almost always is furnished with three or four pairs of stout bristles. It is to be noticed that when the nectaries 1 – 8 +

are nearly suppressed, or are entirely wanting, the tail also is mostly small, or altogether absent. Some genera show this organ free, and distinct from the ring to which it is an appendage, but other genera have a power of retracting it, more or less, within the cavity of the body.

On this account I have not laid so much stress upon the value of its length, as Passerini has done, who measures its length against that of the cornicles.

The colour of the *Cauda* is pretty constant in species, and therefore should be noted.

Below the anal plate, two darker coloured opercula or valves occur, which close the vaginal orifice, and constitute the "Afterlappchen" of Kaltenbach, who takes advantage of their difference in colour for discriminating species.

The terminal abdominal rings of the males differ much from those of the females. Two *papillæ* occur, which have offices similar to the claspers of other insects, and also tend to strengthen the very curiously formed male organ, when it is protruded.*

The description of the ano-genital apparatus will be comprised in a later section of this Monograph.

THE WINGS.

In by far the greater number of cases the males and viviparous females of Aphides are provided with four wings, by which they transport themselves into other localities, either in seach of fresh food, or for the purpose of founding new colonies. Some species of the *Rhizobiidæ* or root inhabiters have, so far as we at present know, no alate forms. Other species, few in number, do not complete their metamorphosis in this country, yet do so abroad. To quote an example, *Chaitophorus salicivora*, so plentiful on our willows, is known here only in its immature form.

* *Vide* Plate B, fig. 7, and Plate XII, fig. 5.

The two upper wings are considerably larger than the two lower, and have no coriaceous portion as in the Homoptera proper. An approximation to this structure, nevertheless, may be seen in the wings of *Chermes* and other allied genera. The wings are attached to the *mesothorax* by an enlargement of the basal portion of the main veins.

In describing species I allude to these swellings by the term "*wing insertions*." They often are brighter in colour than the rest of the insect, and are distinctive.

The lower wings are united by similar attachments to the *metathorax*. A compound *hooklet* is fixed on the costal margin of each lower wing, which works in a strong fold or thickening of the posterior margin of the upper wing, so that a continuous vibrating surface is formed by the two membranes during flight.*

The nervation or venation of these organs is of great value for subdividing the family into suitable genera. Frich in Germany, Harris in England in 1782, and Jurin in Switzerland in 1807, appear to have been the first to propose constructing genera of insects upon the basis of a distribution of their wing veins. Later, Shuckard, in this country, adopted the same method for arranging the Hymenoptera; the nervation of which, however, is far more complex than what we find in these Homoptera.

The late Mr. Francis Walker discussed the same subject in the 'Entomologist' for February, 1874, p. 36 *et seq.*, where he embodies some posthumous papers on wing nomenclature, by the late Mr. Haliday.

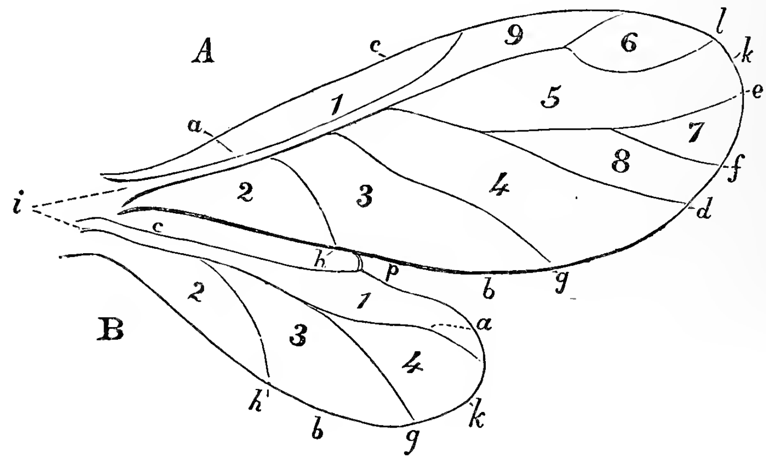
Amongst Aphides caution is necessary, lest the not infrequent abnormal characters of nervation should mislead us. Nervation sometimes accidentally varies on each wing. Sometimes we find supernumerary veins, sometimes they abnormally anastomose, and occasionally even they are absent altogether. Reference, therefore, to several specimens should, if pos-

* *Vide* Plate XXII, fig. 6.

sible, be made where any unusual distribution of the veins may be noticed.

The strongest nerve in the wing is styled the cubitus or post-costal nerve. It expands at its apical portion into the stigma, from which the fourth or stigmatic vein proceeds.

As the section Aphididæ possesses the most elaborate venation of the Family, such a typical figure of a wing is subjoined as will comprise the genera it contains. In this manner it will be understood that the construction of the wings of other sections may depend



A. Upper wing of Siphonophora.
B. Lower wing.

a. Cubitus or post-costal nervure.
b. Posterior marginal.
c. Costal nervure.
d. Cubital nervure.
e. First furcal.
f. Second furcal.
g. Second oblique.
h. First oblique.
i. Insertions.
k. Apical marginal.
l. Stigmatic.
p. Hooklet.

1. Costal cell.
2. Basal cell.
3. First discoidal.
4. Second discoidal.
5. Infra-marginal.
6. Marginal.
7. Second cubital.
8. First cubital.
9. Stigma.

N.B.—The same letters apply to each wing.

upon the suppression or modification of these nervures.

Three oblique veins start from the cubitus or post-

costal nervure, that nearest the stigma being called the cubital nerve. It occurs either simple, once, or twice forked, and thus it is characteristic.*

The cells of the wings in general take their names from the neighbouring veins, as shown by the figure attached.

In the genus *Callipterus* the nerves have a tendency to flatten or expand their diameters towards the apical margins of the wings. They then often have an elegant clouded or brocaded appearance.

The wing membranes are exceedingly delicate, and so thin that they reflect all the prismatic colours of the soap-bubble. This character is more richly seen in some species than in others. Occasionally the membranes are finely punctured.

The stigma is a broad expansion of the post-costal nerve, and connects the same with the costal. It forms the most coriaceous portion of the upper wing, and varies much in form and colour. Usually it is finely punctured, slightly scaly, or strongly imbricated.†

Aphides show a peculiarity in folding their wings when at rest, which is not usually seen in other insects.

In most genera they are carried vertically with the costal nerve placed downwards, and therefore not as in the diurnal Lepidoptera.

In *Vacuna*, however, the position is different, for the wings almost overlap each other, and then they fold themselves horizontally, as in most of the Homoptera Heteroptera, and other orders of insects.

* In Kaltenbach's explanation of his fig. 7 the term cubitus is given to what I describe as the cubital nervure (*d*). That which I name the cubitus (*a*) he calls the under-marginal vein (unterrandader).

† *Vide* Plate B, fig. 8.

THE LEGS.

Although wingless Aphides rarely move far from the spot where they were born, many species possess very long and thin legs. Sometimes these are clothed with numerous fine hairs ; at other times they are smooth and naked. Some species have legs so short that they scarcely project beyond the circumference of their bodies.

The *fulcra* are but little developed in this family, and often are difficult to distinguish at all. The *coxæ* or hips have several forms, and exhibit different modes of rotation on their *fulcra*. This varied rotation has been adopted by Schiödte as a guide to the classification of the Rhynchota.*

The *femora* and *tibiæ* often much differ in their relative lengths and proportions. The latter occur either straight or curved, smooth or *hirsute*.

The hind *tibiæ* of the oviparous females are often remarkably flattened, and sometimes tuberculate. This conformation probably assists her in fixing her eggs by their glutinous coats to the buds and twigs of trees.

In by far the greater number of species we find the tibiæ terminating in a single-jointed *tarsus*, armed with two sharp and strong claws. Nevertheless, in almost every instance, an obsolete second joint to the tarsus may be detected under a slight magnifying power. This joint becomes so pronounced and complete in its articulation in the Lachninæ and Pemphiginæ, that it may be considered as a true second joint.

The three pairs of legs, as before noticed, are fixed by their *fulcra* to the Pro-, the Meso-, and the Metasternum. The outer joints or tips of the femora (knees), tibiæ, and tarsi are commonly darkly coloured or shining black.

The extensor and flexor muscles are well developed

* Schiodte, "Naturhist. Tidsskrift," 3 ser., vol. vi. Translated, 'Ann. Mag. Nat. Hist.,' 4 ser., vol. vi, pp. 222–249.

in both the femora and tibiæ of Aphides, and may be easily seen after treatment with acetic acid. They often also become obvious after the insect has been some time mounted in Canada balsam. In the *femur* the muscles are compounded of broad fasciculi.

The base of the tibia is expanded into a soft cushion or retractile sac, which is regulated by a distinct muscle and ligament. Probably this organ acts as a *pulvillus*, to secure foothold on the glossy surfaces of leaves.

The tarsus is attached to the horny plate of the tibia by a fine joint, and an elastic membrane.

(B) INTERNAL ANATOMY.

The dissection and manipulation of Aphides present peculiar difficulties, partly on account of their diminutive size, and partly from the extreme tenderness of their viscera, which in great measure break up by immersion in fluids employed in dissection, which do not approach the density of the surrounding animal juices. I regret that our knowledge of the internal anatomy of Aphis is yet far from complete; nevertheless, I may be permitted to add some observations I have made, with reference to their alimentary, circulatory, and respiratory systems.

THE ALIMENTARY SYSTEM.

Aphides possess a gullet of some length, but of small diameter. It ends in a considerable dilatation or stomach, which apparently has no villous coat. Usually it is charged with a pulpy mass, which seems to gather into pellets, which are transferred to a long intestinal tube for assimilation. Proceeding from the lower end of this pouch, the alimentary tube descends to a broader sac, which, having its opening at the anus, may be regarded as the rectum, or the cæcum.

The alimentary canal varies greatly in length. In some genera it attains twice or thrice the length of the body, within which it undergoes several convolutions. Some species show it shorter, and apparently looped back, before communicating with the rectum. In other cases it is very short and comparatively straight. In Plate C, figs. 1 and 5, the alimentary apparatus is represented, but the drawings do not profess to show the exact form of the folds as they lie in the living insect.

SALIVARY GLANDS.

These organs are not of uncommon occurrence amongst the Hemiptera Homoptera, and are almost always of a simple character. Léon Dufour shows by a figure that they are distinct and well developed in Cicada, but states that he could find no trace of them in either Psylla or Aphis. He admits, however, that his microscope was hardly adequate in magnifying power to examine this latter family. The internal tissues of Aphides are of extreme tenuity and transparence. They break up on very slight pressure, and therefore it is desirable to dissolve sugar or common salt in those fluids which are employed for dissection.

In those specimens of Aphides in which I have detected salivary glands, they appear as rounded pyriform bodies, situated in the immediate vicinity of the base of the rostrum, and partly filling the cavity of the thorax.

These masses consist of bundles of delicate vessels ranged side by side into distinct lobes. Morren noticed like appendages to the head of the Aphis he describes as *Aphis persicæ*.

HEPATIC VESSELS.

Although Léon Dufour* failed in detecting any biliary vessels in Aphides, I believe that in some genera they exist. In *Amycla* I have seen a kind of beaded chain attached to the lower end of the alimentary canal, which, from its position, I should conclude belonged to the hepatic system.

In *Psylla* the alimentary system is more complicated than in *Aphis*. The stomach has the œsophageal and

* Léon Dufour, 'Recherches Anatomiques et Physiologiques sur les Hemiptères,' p. 118, *et seq.* This author says the minute size of Aphides should be no bar to discovering the hepatic organs, if they existed.

pyloric entrances both at one end, whilst a blind annular tube proceeds from the other end of the stomach, from the walls of which tube several bead-like vessels depend, which Dufour refers to the biliary system, "vesicules biliares."

Sir J. Lubbock says that in Pentatoma (Heteroptera) the biliary vessels pour their contents into the rectum below the ilium, but in no other group of insects, except, perhaps, in the Homoptera, do the biliary vessels open elsewhere than at the anterior end of the ilium, or the colon.

RESPIRATORY SYSTEM.

The tracheæ in Aphides are very numerous, and are disposed over almost every part of the body. They are particularly numerous round the bases of the cornicles, but they do not appear to be at all connected with them. They also are well developed in the thoracic region, and accompany the great nervures of the wings, without apparently opening into them. These last tubes may sometimes be seen, after the fresh wings have emerged from the wing cases of the pupæ, and whilst the membrane is soft and supple; but the wonderful expansion and growth of the wing, certainly in Aphis, is not caused by air being pumped into these nervures or by dilatation of the tracheæ.

The ovarian system is well supplied with these vessels for aërification.

As in other insects, the tracheæ start, in trunks of considerable diameter, from certain pulmonary sacs, which have their communication with the outer air, through their respective stomata. These large trunks abruptly give off numerous finer tubes, which form distinct tufts in each ring of the body. A large tube takes a zig-zag form down each side of the back, into which the finer tracheæ anastomose.

In many transparent species these tubes appear like

white silvery threads through the skin, and are so disposed that they often give an appearance as if here the skin of the insect were cut up into dorsal plates.

I have failed to trace in other insects the spiral thread so commonly seen to traverse the interior of these tracheæ.

The removal of carbonic acid and the oxygenation of the animal juices is probably in great measure effected by diffusion of the gases. The tracheæ speedily empty themselves of air after the death of the insect. Air would appear to be here in some condition of solution, for it is a curious fact, that the insect plunged into ether disengages a stream of bubbles from each stoma, the volume of which, if collected, would equal the size of the whole body. This expulsion of air has been many times seen on the stage of the microscope.

Sir John Lubbock has shown how the tortuous form of the tracheæ permits perfect freedom in the motions of an insect, and allows of considerable extension and contraction of its body.

THE CIRCULATORY SYSTEM.

Up to the present time no distinct dorsal vessel with definite walls has been discovered in Aphis. That some such vessel exists is very probable, from the slow vermicular motion, often to be traced down the medial line of the upper side in several transparent species. I have seen this motion distinctly in *Callipterus coryli*, and yet better in *Drepanosiphum platanoides*. It is remarkable that whilst submergence in water speedily kills most Aphides, some will live many minutes under the ordinary paraffin oil now so much used for illumination. They will also live for half an hour under weak glycerine, and thus their circulation may be watched on the microscope stage under either of these liquids. As a

rule the younger individuals have the greatest endurance of such treatment.

I examined, for a quarter of an hour, the motion of the dorsal apparatus of *D. platanoides* under paraffin oil. There was a regular pulsation of about 40 beats in a minute. The constriction appeared to begin from the thoracic region, to proceed down the back, and then to end at the last abdominal ring, where there appeared to be a transparent sac, which repeatedly contracted, and probably forced a colourless liquid over the body. I have in vain looked for particles analogous to the oat-shaped corpuscles to be seen in the wing nervures of *Chrysopa* and other insects. The oil-globules, so freely distributed over the bodies of Aphides do not circulate, though they slightly change their position during the inhalation of air through the stomata.

A remarkable circumstance is connected with the circulation in Aphides, viz. the presence of a pulsating sac at the knee-joint of each tibia. Under petroleum spirit I have watched these contractions for twenty minutes, and counted them at from 120 to 180 in a minute, according to the activity of the insect. Under a $\frac{1}{12}$ objective, I have noticed a current of fluid pass down one side of the leg and a return up the other. This was indicated by the movement of two or three globules (oily ?) which occasionally came in sight. This observation of moving particles in the blood of the living insect, however, is by no means easily made.

By treatment with dilute chromic acid after death, the walls of this sac may be traced.

Cuvier and Léon Dufour have recorded their opinions, that when there is a circulation of air through the body of an animal for respiration, we ought not to expect a circulation of the nourishing fluid or blood. The latter author doubts even that the "cordum dorsale" of insects acts at all as a circulatory vessel. He says, that after twenty years' practice in dissecting insects, he cannot prove it to be either a secreting or a circu-

lating vessel, and prefers to consider it as "un vestige anatomique."*

Since, however, the more recent labours of Straus Durckheim, Carus, and others, we can speak with confidence on this matter.

The former showed the muscular character of the dorsal vessel of *Lucanus cervus*, and proved, by the presence of valves, that the blood is truly propelled forwards. Newport also showed the characters of a true heart in *Sphinx*, and Dr. Bowerbank likewise has demonstrated the circulation of fluids in the nervures of the wings of *Ephemera* and *Chrysopa* by means of a dorsal heart.†

The thorax and abdomen of many Aphides are provided with certain glandular organs which secrete and exude, often in a beautiful spiral form, a peculiar flocculent substance that has some analogy to silk.

In some species this substance is so abundant that it entirely conceals the insect. In *Phyllaphis fagi* these flocks equal in length the whole body of the insect.

Occasionally the fibrous character is nearly lost, and the material takes the appearance of a fine meal, which gives the Aphis a hoary or pulverulent aspect.

Two or three species follow the habits of some Lepidoptera in stripping their bodies of this silky coat, for the purpose of covering their eggs. Such an example may be seen in *Chermes laricis*. Some Cocci also very beautifully conceal themselves by a similar device.

* Dufour remarks, 1. C'est un fait établi, je crois, en principe, que dans les animaux où il y a une circulation générale d'air, celle-ci remplace ou exclut la circulation générale du sang ou d'un liquide analogue. Ces deux systèmes circulatoires simultanés sont incompatibles. Je m'abstiens d'examiner les conséquences qui découlent naturellement de cette proposition; elles sont par trop évidentes. 2. J'ai déjà avancé que dans l'échelle entomologique les Hémiptères, comme insectes suceurs, avaient une organisation moins compliquée, moins parfaite, que celle des insectes broyeurs. La considération du cordon dorsal vient à l'appui de mon assertion, car il est encore plus simple, plus grêle, plus rudimentaire, chez eux que dans les insectes à mandibules. *Vide* Léon Dufour, p. 276, "Recherches Anatomiques," op. cit.

† *Vide* Bowerbank, 'Entom. Mag.,' vol. i, p. 244, and vol. iv, p. 179.

Mainly through the repellant action of this meal, or down, the subterranean Aphides are enabled to live securely in the holes they excavate in soils which are often percolated with water.

Under high magnifying powers this silky secretion appears as long flattened fibres, which, when broken across, present sharp fractures as if they were brittle like glass or asbestos. The fibres are mostly curved, and have obscure transverse and longitudinal striations. It issues from the glands in dense shining tufts, which usually have their tops truncated. This is well seen in *Amycla* and *Forda.*

This material is insoluble in water, in alcohol, and in solution of potash. It scorches into a brown mass over the lamp, without melting; and gives off, at the same time, a nitrogenous odour like burnt feathers. This substance, therefore, differs from the secretions formed by many other Homoptera, which generally are of a waxy nature. For example, this matter is abundant on the bodies of some lantern flies, where it occurs in filaments exceeding the length of the body. It occurs also either in tufts or in a pulverulent form amongst the Cicadidæ; those feeding on the thistle or nettle roots being most profusely furnished. The white flakes often obtained by shaking our box-trees proceed from the bodies of *Psylla buxi.*

The crystalline, spermaceti-like substance known in commerce as Chinese wax is the produce of *Coccus pela*, and Mr. Walker states that a waxy secretion is obtained from an Arabian Coccus, which some have fancifully supposed might be identical with the manna of the wilderness. Thus, individuals of all the insect families nearly allied to Aphis cover themselves with flocculent matter, of varied constitution.

A description of the silk glands of Chermes, and the peculiar mode in which the silk unravels itself, after leaving the pores, will be found in connection with Plate C, figs. 6—9.

Before concluding these observations on the anatomy

of Aphides, I may remark that it is very important to refer to adult forms for all specific characters, and that as a rule, the winged insects are more to be relied on than the Apterous. Young individuals, particularly those of the broods early in the series, often show but partial development of the tail and antennæ.

The last-mentioned organs, indeed, mostly want the normal number of joints.

THE HONEY DEW.

As no little discussion has arisen with reference to the nature and the source of this substance, the following observations may not be unacceptable.

This secretion—for all admit it to be such—is plentifully sprinkled over the upper surfaces of the leaves of various trees during the summer. It is more particularly abundant in the hot weather upon the foliage of the lime and sycamore trees, but often the leaves of the plum are brought into an almost disgusting condition from the glutinous liquid which covers them. Honey dew usually appears in the form of shining spots which, from their sweet taste, and the fanciful idea that it fell from the skies, has received from early writers the name of nectar.

I quote Messrs. Kirby and Spence's remarks on this subject:—" You have doubtless observed what is called the honey dew upon the maple and other trees, concerning which the learned Roman naturalist Pliny gravely hesitates whether he shall call it the sweat of the heavens, the saliva of the stars, or a liquid produced by the purgation of the air. Perhaps you may be aware that it is a secretion of Aphides, whose excrement has the privilege of emulating sugar and honey in sweetness and purity." " It issues in liquid drops from the abdomen of these insects, not only by the

ordinary passage, but also by two setiform tubes placed one on each side just above it."*

De Geer and Kyber remarked that this secretion is not expelled from the cornicles of Aphides, as is usually supposed, but that it is voided from the anus of the insect. Any observer may prove the forcible ejection of a liquid from this last passage by gently stimulating with a bristle the abdomens of the full-fed individuals of a colony of *Lachnus saligna*, a large black Aphis which sometimes infests the willow tree in such quantities that occasionally it kills it.† Many of these insects will, by this treatment, erect the terminal rings of their bodies, upon the apex of which a clear drop of fluid will, for a moment, appear. If this is not quickly withdrawn by an attendant ant, usually in quest of the sweet morsel, it is projected by a peculiar jerk to a considerable distance, and it is caught on the upper surfaces of the leaves below.

The same action may be seen in the black masses of the elder Aphis, *Aphis sambuci*, which also are much visited by ants for the same purpose.

A similar sweet secretion is elaborated by *Psylla cratægi*, which also appears to be acceptable to ants, since they resort to them largely and intermix with their companies.

It may be stated that the substance of Kirby and Spence's remarks is accepted as true by almost all aphidologists, dating from the veteran De Geer to Kaltenbach, Koch, and Passerini.

There are, however, other observers who ascribe a vegetable origin to the honey dew. Their objections seem to be principally based on the presumed absence of Aphides on the leaves which are loaded with the saccharine matter. Yet it is well known that Aphides crowd almost exclusively the lower surfaces of the leaves which grow on trees of great elevation, and thus, after

* Kirby and Spence's 'Introduction to Entomology,' vol. i, p. 210, and vol. ii, p. 18.

† *Vide* Mr. Smee's account of their ravages on the willow in 'My Garden,' pl. xxiii, figs. 1—4, p. 477.

repletion, they sprinkle the lower leaves. Even when no Aphides are feeding above, myriads of the winged forms often fill the air of a hot summer's day, and void their juices whilst on the wing just as we see amongst some of the Lepidoptera.

Dr. Hooker, in the 'Gardeners' Chronicle' for July, 1873, endorses Liebig's opinion that the honey dew must not be ascribed to the agency of Aphides. The objections urged by him were combatted by the late Mr. Francis Walker, in one of his papers contributed to the 'Entomologist' of the same year.

The Abbé Boissier de Sauvage thinks that the secretion under consideration may have both an insect and a vegetable origin; and Mr. H. Doubleday ascribes the dropsical condition which he has observed in some currant leaves to a disease which causes the transpiration of a fluid from their pores.

M. Boussingault* further denies that the saccharine matter found on lime leaves is the produce of Aphides.

He states that whilst on a visit to Liebfrauenberg, on the 22nd of July, he found the secretion sufficiently abundant to fall upon the ground. He describes it, indeed, as "a rain of manna." This liquid thickened in the heat of the sun, and formed a sort of varnish on the upper surface of the leaves. He collected some of it by means of a moist sponge, and then diluted it with water. Subacetate of lead precipitated from the solution a quantity of albumen and mucilage, after which the clear liquid was allowed to stand. Small crystals were then slowly deposited, which he subsequently identified as those of cane sugar.

Again, by an examination with polarized light he found, in addition to the above substances, the presence of dextrine, and an intermediate or inverted sugar, which showed under the prisms an abnormal index of rotation.

* Boussingault, "Observations sur une matière sucrée apperçue sur les feuilles d'un tilleul," 'Comptes Rendus,' 1872, tom. 74, p. 87.

Boussingault remarked, also, that as the autumn approaches, the quantity of cane sugar in the samples experimented on increased more and more. He further found that the aqueous solution was fermentable by yeast, and that during this process the whole of these sugars disappeared.

No mannite was found, but the composition of the secretion in August, he states, is identical with that of the "manna of Sinai," which substance Ehrenburg and Hemprich have discovered to proceed from the pricking of the leaves of *Tamaris mannifera*, by an insect known as *Coccus manniparus*. These authors describe this manna as falling upon the ground from the trees, and in such quantity that the Arabs eat it with their bread as if it were honey.

The analysis, as given by the polarizer, by Boussingault is stated to be as follows:

Cane sugar . . .	48·86
Sucre interverti . .	28·59
Glucose . . .	22·55
	100·00

He says he extracted as much as 26·7 grammes of these mixed sugars from one square mètre of diseased lime leaves; but only 4·4 grammes of the same from the leaves of the unaffected lime trees growing not far from the same spot.

M. Boussingault calculates that a sick tree of "le tilleul du Liebfrauenberg"—for he considers the flow of this secretion to be a disease—may contain as much as from two to three kilogrammes of this manna. He points out that although it has the same composition as "manna of Sinai," it has quite a different origin.

In the same year* this notice was answered by M. Harting, who says, that observation permits him to affirm that this same substance is the excrement of

* Harting, 'Comp. Rend.,' tom. 74, p. 472.

Aphis tiliæ. He collected it from numerous individuals which voided it whilst on the wing. They rained it on glass plates placed to receive it, and the deposit was analysed afterwards by Professor Gunning, of Amsterdam, who stated that, very unexpectedly, it principally consisted of cane sugar, and not of grape sugar or glucose.

Boussingault* finally answered that he could prove that the fresh lime leaves contained cane sugar, although less richly than can be shown by the diseased leaves. As also the secretion he examined contained both glucose and dextrine, it could not be, he conceived, the produce of Aphides.

In another paper Boussingault describes a kind of manna which he obtained from the berries of the Service tree, but he does not connect this notice with the asserted vegetable origin of the honey dew.

I am very much of the opinion that this honey dew, *as found upon leaves*, is of Aphis origin. The evidence of the polariscope, without an appeal to a sound chemical analysis, is not, I conceive, sufficiently strong to decide definitely against such an origin. Besides all this, the presence of dextrine need create no serious difficulty, since it is well known that saliva and biliary products, such as Aphides may be capable of secreting, produce dextrine by their action on starch.

Future inquiry will clear up the question whether this liquid is identical with that discharged from the cornicles, and which, in some full-fed insects, even exudes from the pores disposed down each side of the dorsum. Often this transpiration may be seen in *Aphis cinerariæ*, of which I give a figure, but such an exudation is by no means confined to this species.

It will be borne in mind that the siphuncles of Aphides are often styled nectaries, from the general belief that they emit the sweet liquid in question.

As an appendix to the above remarks I may add a

* Boussingault, same vol. p. 473; also tom. 74, p. 939.

note taken by myself at the moment, which bears on this subject:—"Bright sunny morning. The undersides of the oak trees well tenanted by winged and apterous females of *Callipterus quercûs*. The upper surfaces of the leaves of the Portugal laurels, growing under the oaks, are freely sprinkled with shining spots of honey dew. On gently touching one of the *winged* females the abdomen was raised, and a bright particle, easily seen in the sunshine, was projected from the summit of one of the short *cornicles*. The garden seats on the open lawn are also sprinkled with the same spots. This last fact can scarcely be reconciled with the idea that honey dew is of vegetable origin."—Weycombe, Haslemere, Aug. 23rd, 1874.

Many virtues have been ascribed to the honey dew. Professor Passerini* tells us that in some parts of Italy the villagers collect it from the elm tree, and use it as a vulnerarium under the name of Olia di S. Giovanni. A knowledge of the quasi-healing properties of the liquid does not, however, appear to be confined to the peasants of Italy. Bonnet says both ants and physicians resort to Aphides for their secretion, "dont la médecine fait usage."

A recent writer also says—"That the liquid found in the pseudo-galls of the elm is, under the name of Eau d'orme, collected in France, and is supposed to be a cure for sore eyes. After the galls are dried, a balsamic residuum is found within them, which, under the name of "Baume d'ormeau," has some reputation for diseases of the chest.†

Occasionally in this country very large purses or pseudo-galls, equalling the bulk of a large fig, may be gathered from the wych and other elm trees. If they are opened before the contained Aphides have generally assumed wings, they will be found to enclose a considerable quantity of a liquid which has a mawkish sweet taste. I have obtained globules of this

* Passerini, 'Prospetto dei Generi della Famiglia degli Afidi.'
† Note by M. C. Cooke, 'Ent. Month. Mag.,' vol. iii, p. 190.

fluid from moderate-sized pouches, as large as hazel-nuts; nevertheless, this watery substance does not appear to incommode the inhabitants, for it is lodged in a quantity of meal-like powder or flocculent matter, which effectually protects them from drowning.

The history of *Pemphigus bursarius* which constructs these curious gall-like excrescences will be treated of under the diagnosis of that species, but here it may be said, that doubts must be expressed as to the liquid above noticed being a secretion from the Aphides;—it is too large in quantity. It is more probable that it consists of transuded sap, occasioned by the punctures and incessant irritation set up in the walls of the purses by the rostra of the Aphides.

In this opinion I am glad to be supported by Mr. M'Lachlan, who described in 1866 some large galls he found on the elms near Deal. They were made by *Schizoneura ulmi,* and filled with a similar liquid, which he considered to be sap, mixed with a white powder.*

On the other hand, Kaltenbach describes this liquid as a "whitish, thick honey dew, of which one could fill a middle-sized thimble."

Although it may be thought somewhat fanciful to ascribe urinary functions to the cornicles, as some authors have done, yet there can be no doubt of their offices as excreting orifices of some kind. When we consider that the life of an Aphis is almost wholly spent in pumping into its body vegetable sap, we may ask into what form does the effete matter pass?

We have seen that Aphides are provided with a distinct stomach and alimentary canal, ending in a cæcum, and that certain fluid products are from time to time forcibly expelled from its exit. It is clear that the cornicles do not functionize in this manner. I have been unable to trace with certainty any gland at the base of these tubes, although in several instances I

* *Vide* 'Entom. Month. Mag.,' vol. iii, p. 157.

have clearly seen a continuation into the soft parts of the body of the inner tube or duct, which undoubtedly traverses the cornicles.

By far the larger portion of the cavity of the body in Aphis is taken up with the ovaria and the forty or fifty embryos in a more or less advanced stage of development; but surrounding these and the other organs, there is a mass of transparent fluid, charged with numerous globules of an oily nature, and which often are of beautiful pink, green, yellow, or violet shades. Towards the autumn these globules increase largely in quantity, and are found most plentifully stored around the bases of the nectaries or cornicles. There would seem to be reason for believing that the cornicles are in immediate connection with these apparently unconfined fluids; at any rate, the oily globules freely pass to the exterior through the cornicular channels, and would thus appear to relieve the insect of that which would cause its death if allowed unduly to accumulate. Death actually happens, if these oily spherules crystallize in the nectaries and choke them. In such cases the whole body seems to pass into a semi-crystalline condition,—partly fatty, and partly saccharine.

Occasionally this adipose matter exudes from the summits of the cornicles in large drops, which crystallize into botryoidal masses, having a radiated structure similar to cystine, or else to margaric, or some such homologous fatty acid.

Léon Dufour* thinks that the adipose matter, so abundantly stored in some insects towards autumn, may possibly play some part towards their maintenance in winter, just as we find in hybernating animals.

If we search in July the distorted and curled leaves of the elm, inhabited by *Schizoneura ulmi*, we shall probably notice a number of shining, colourless, and

* 'Recherches anatomiques et physiologiques sur les Hémiptères,' p. 143.

spherical bodies which freely roll about on any smooth surface.

If one of these vesicles—all of which glitter like white sand grains—be placed on a slip of glass and breathed upon, it immediately falls into a drop of moisture, without showing a trace of any organization. They look exactly like ova, but are not such. These globules are fæcal matter, discharged from the anus of the insects, which swarm within the curled leaves, and their spherical form is due to the presence of the fine meal-like powder taken from the bodies of the Aphides, and which gives a character repellant of moisture to these globules.

By this peculiar dusting of their surfaces the insects are not incommoded by their own excreta, for the liquid refuses to soil what it touches, just as drops of dew will run off the glaucous coat of a cabbage leaf.

It is possible that the hoariness of some species may be a protection to them from rain very much in the same manner. The globular granules above noticed may be seen also in the tangled purses made by *Cryptosiphum silenes* and likewise in other close habitations of Aphides.

References will be made elsewhere to those chemical characters which can be traced in such Aphis secretions as can be secured for examination. Necessarily these quantities must be small in amount.

§ II. BIBLIOGRAPHY OF APHIS.

About the year 1690, in Delft, the celebrated anatomist and philosophical lens-grinder, Leuwenhoek, proved by his dissections that Aphides often contained within their bodies numerous young, more or less ready for birth. Reaumur subsequently noticed the same peculiarity, and stated that these insects did not follow the general mode of multiplication by means of ova.

Reaumur, in his famous work on Insects, published in 1737,* treats at some length upon the family, and figures and describes, *le Puceron de rosier*, *le P. d'érable de montagne* (sycamore), *le P. de tilleul* (lime), *le P. de saule* (willow), and others. His interest was principally excited by several of the species which formed false galls on various trees, and he particularly notices the habits of *le Puceron de peuplier noir*, *le Puceron de lentisque*, and *le Puceron de térébinthe*. He tells us that he found in some years considerable swellings on the bases of the elm leaves. Commonly they were of the size of hazel-nuts, but occasionally he discovered monstrosities which approached the size of a man's fist.

Geoffroy had before described these singular vegetable growths. He gathered them to compare with "les vessies" brought, in his time, from China, to heighten the colour of certain dyes then in vogue. On opening these pseudo-galls he was greatly astonished to find them tenanted by thousands of plant-lice.

Savory previously had explained that the Turks mixed with their red dyes varying proportions of a gall they called "bazgendges or baizonges." The scarlet they obtained from cochineal was thought to be heightened by such a mixture. Reaumur showed

* 'Mémoires pour servir à l'Histoire des Insectes,' tom. iii, mém. ix.

that these "baizonges" were identical with the galls formed from the terebinth by *le Puceron de petolin.*

Goedaert seems to have been the first to show the friendly relations which exist between ants and *Aphides.* He even goes so far as to give imaginary conversations between the two insects upon such subjects as relate to warning them of the approach of their enemies. Whilst praising the general accuracy of this author, Reaumur says that he committed a great error in adopting the then popular prejudice that ants were the true mothers of Aphides.

Reaumur describes several insects which prey on Aphides, and particularly he refers, by their local trivial names, to *Syrphus*, *Coccinella*, and *Hemerobius*. He also shows that Aphides are liable to the attacks of a fly which inserts its eggs within their bodies and destroys them.* Like Leuwenhoek, Reaumur failed to discover the males and females of Aphides, viz. those perfect sexes which subsequently have been proved to end each individual series. Failing in this discovery both authors concluded that these insects were true hermaphrodites.

Reaumur thought the results of his experiments, though incomplete, were so remarkable, that he prevailed on his friend Charles Bonnet, of Geneva, to continue them, feeling sure that they would well repay the labour bestowed on investigating their history.

Bonnet appears to have been an enthusiastic naturalist, and a man of good fortune. He was thus enabled efficiently to conduct experiments at his comfortable château, situated at the little village of Geuthod, at the foot of the High Alps of Savoy.† For many consecutive years he studied the habits and mode of reproduction of Aphides. The results of his labour and sagacity are embodied in his celebrated 'Mémoire pour

* Reaumur, op. cit., p. 331.

† In the frontispiece of the work above mentioned Bonnet gives us an engraved representation of his château, with its ornamental grounds.

servir à l'Histoire des Insectes,' and his ' Œuvres d'Histoire Naturelle et de Philosophie,' published at Neuchatel in 1779. There is no cause for wonder that the publication of the novel and unexpected facts he brought to light—particularly those connected with the parthenogenesis of Aphides—should have provoked discussion and much opposition. Evidence of this opposition is to be found in the heap of voluminous literature extant, the production of which has, almost without cessation, increased to the present day, and even yet shows no sign of abatement. Notwithstanding the lapse of time, a perusal of Bonnet's work on this family will repay the reader of to-day. Indeed, we must be struck by the circumstance that to his *address* and concentrated attention we are mainly indebted for some of the most important points relating to their life-history.

A short sketch of Bonnet's observations may not be considered uninteresting.

Early in his treatise he points out the resemblance that "*les pucerons*" proper bear to "*les faux pucerons*" of Reaumur, who had separated them into a group by themselves under the name of "*les moucherons sauteurs*," alluding to their leaping habits. This group consists of the *Psyllidæ*, of which Reaumur describes two species, viz. that infesting the box-tree (*Buxus sempervirens*), and that which, in France, appears to attack the fig-tree (*Ficus*). Bonnet divides his *pucerons* proper into two principal sections, viz. those which possess cornicles and those which want the same. He remarks that the family is rich in species, and that the plants attacked by them are extremely numerous. He states, not only are there many kinds which feed on leaves, on flowers, and on the twigs of trees, but there are those which form companies under ground, and attach themselves to roots. Remarking on the large swellings not unfrequently found on the elm-tree, ("*grosses vessies*"), he points out the differences between these distortions and those formed by ordinary gall-insects. He after-

wards attempts to explain that these tumours arise through the law that soft bodies under pressure, like liquids, rush to the points of least resistance. Accordingly, he attributes the tortuous bending of such leaf-structures, and their singular modifications into bladders, &c., to the effects of insect puncture and irritation, which causes the exudation of the softer parts.* Bonnet gives a lively description of the attacks made on Aphides by their numerous foes. He commences with the larva of the "*mange puceron*" (Syrphus), which, seated on a leaf or twig, transfixes and cuts with its trident-armed head into its helpless prey, so that, he says, in nature perhaps there is no "animal carnacier qui chasse avec plus d'avantage." He then goes on to notice the voracity (previously observed by Reaumur) of "*le lion des pucerons*" (Hemerobius), and also the insatiable appetite of "*la vache à Dieu*" or "*bête de la Vierge*" (Coccinella). Even "le petit ver que le puceron nourrit dans son intérieur, et qui lui donne la mort" (Aphidius), does not escape his observation. He winds up his remarks on these enemies by observing, "Like as we sow grain to provide for our own subsistence, so it appears that nature sows 'les pucerons,' on all kinds of trees and plants, for the nourishment of multitudes of different insects."

Subsequently Bonnet enters upon the most important part of his work on Aphides, viz. their peculiar mode of reproduction. He refuses to discuss the opinion of the old philosophers, who maintained that Aphides were engendered of the dew, or to argue upon the before-mentioned notion of Goedaert, who pretended that they spring from the moist "*semence*" deposited by ants. Bonnet, to put an end to mere

* Bonnet is by no means so happy as Reaumur in his explanations of how these monstrosities are produced. The latter author gives many interesting plates, showing how helical curves and vasiform masses may be produced through the continued punctuation of normal vegetable growths. Bonnet is indebted to Reaumur for many of his remarks, and also for most of the figures of his memoir on Aphides.

conjecture, took an *Aphis*, which was born under his own eyes, and brought it up without contact with any insect of its own kind. Reaumur said to Bonnet, "If this insect should multiply, it must be without sexual union, or at any rate, if such a union had by possibility happened, it must have taken place within the body of its mother and previously to its own birth." The first experiments were made on "*le puceron du fusain*" (Euonymus), a female of which, he tells us, he isolated so effectually that no opportunity could again occur for a second history of Acrisius and Danäe. Bonnet then commenced a regular diary of the life of this insect. He noticed that four moultings, or sheddings of its skin, occurred within eight days. Eleven days after birth "il étoit accouché," and to the young *Aphis* he gave the name *la pucerone*. Between the 1st day of June and the 21st no less than ninety-five young were born, after which, he says, "le puceron pert son embonpoint," and that then she took the form of the insect which Geoffroy regarded as the male. Here Bonnet warns observers against hastily concluding that an insect is of the male sex from the mere absence of internal embryos, an absence which might be simply explained by the completion of its efforts in viviparous reproduction. During one day's absence from home his "protégée" disappeared, for which he expresses much grief; he concludes, however, from the collapsed condition of her body, that she could not have contained many more young ones!

Bonnet afterwards isolated a female of the same kind, but of the second generation, with similar precautions, from which ninety other young ones were born. He constructs for these insects a kind of genealogical table, for the purpose of registering their progeny and showing their relationship throughout future generations. In like manner he conducted experiments with "*le puceron de sureau*" (*Aphis sambuci*), which he found to multiply, through nineteen generations, without commerce with the male insect.

He truly remarks that in philosophy nothing is more dangerous than hasty generalisation. His first observations led him to believe with Reaumur that all Aphides were hermaphrodite, and that they were sufficient of themselves for reproduction; but after later observation had made him acquainted with the male and mature female forms he adopted the second hypothesis put forth by our countryman Abraham Trembley, viz. that the influence of the male, as exerted in the previous autumn, was sufficiently powerful to affect numerous future generations, an idea which has been more recently revived by Prof. Owen.* Bonnet tells us that he often observed these creatures consecutively from 4 o'clock a.m. to 9 o'clock p.m. His diligence was rewarded by witnessing under a lens the coitus of a small winged male with the apterous female of "*le puceron de chêne*" of Reaumur, which he calls a very elephant amongst the tribe from its great size and its remarkably extended proboscis. He gives a ludicrous account of the wooing, which was accompanied by a rapid vibration of the antennæ and oscillation of the legs of the insect. He appears to have first discovered the singular recurved penis of the male, and afterwards he describes "*le fœtus*," which he affirms to be "un veritable œuf." Bonnet says that if we argued analogically from the ascertained fact that the females of certain moths and beetles are wingless, we should arrive at the conclusion that the females of Aphides would be also apterous. In the true female which deposits eggs he found such to be the case.

In the years 1773 and 1778 the famous Swedish naturalist Baron De Geer published to the world his 'History of Insects' in seven volumes. In his researches

* Strictly speaking Trembley was a native of Geneva, but naturalised in England. His researches obtained for him the favour of the Royal Society, who in 1743 elected him a Fellow and subsequently awarded him the Copley medal. He discovered that animals like the Hydroida are capable of reproduction, both by a process of budding similar to plants, and also by a process of spontaneous subdivision of their bodies.

on "les pucerons" he more particularly investigated the history of "le puceron du pin" (*Lachnus pini*) and "le puceron du rosier" (*Siphonophora rosæ*).* He groups *Aphides* into two kinds, viz. those which live in companies without producing distortion of the leaves, and those which either form vesicular vegetable excrescences or elaborate gall-like masses from the leaves. In this artificial classification he followed Reaumur. But whilst Reaumur to the last doubted the fact that real eggs were deposited by Aphides, and indeed believed that the elastic oblong bodies found in late autumn were only abortive embryos, De Geer held with Lyonet and Bonnet that they were truly ova. In summer he showed that Aphides were viviparous, and that they only became oviparous towards the end of the year. In the case of "*Aphis nuda pini*" he saw the polished egg deposited in September from the conical and attenuated tail of the wingless female. The mother of this species measured 1·5 lines, and the egg in its longest axis measured 0·75 line. His astonishment was raised at this disproportionate size, for the egg equalled one half the length of the body of the mother. He calls it "un œuf assez gros, et qui semble lui devoir causer assez de peine avant que de pouvoir sortir." In due time he saw some of these eggs hatch, and thus he—at any rate for the time—set at rest the doubts raised by Reaumur.

In the month of September De Geer also saw the union of the oviparous female of *le puceron du pin* with the apterous male. He says the male of this species has the same colour as the female, but it is smaller in all its proportions. Some species of Aphides he found to be wonderfully prolific in oviposition. He examples the birch Aphis, the eggs of which he counted up to the number of 1500. They were all attached to a single birch twig (*Betula alba*), and seem to have been the produce of one female. He notes that a deep

* 'Mémoires pour servir à l'Histoire des Insectes,' par De Geer. 1778.

snow was at that time on the ground. In some other species he found that the number of eggs deposited did not number more than twenty, or even less. De Geer showed that Leuwenhoek was in error when he thought that the apteroûs females acquired wings after having given birth to living young; and again, that after such an acquisition of wings they recommenced the process of viviparition. De Geer, on the contrary, showed that the embryos in the pupæ are in an immature state, and that they do not get their full development until the imago has issued and has attained its complete growth. With reference to "*le puceron de rosier*," he continues, "Il est toujours certain que les pucerons ailés sont vivipares en tout temps, et qu'ils ne pondent jamais d'œufs."

Von Siebold has noticed the curious growth of the eggs of one of the small wasps, *Nematus ventricosus*, which affects the gooseberry tree. This growth takes place after the eggs are laid, and probably it is caused by an absorption of water. Did De Geer contemplate a similar anomaly amongst Aphides when he stated his experience "that after deposition their eggs do not grow to the size of flies' eggs"?

De Geer's most important deductions may be thus summarised:

First. That the oviparous forms never produced living young.

Second. That the viviparous female never deposited eggs.

Third. That at the end of autumn the viviparous females produced those individuals, viz. the males and the females, which, through oviposition, provided the species for the ensuing year, the egg retaining its vitality throughout the rigour of winter.

Fourth. That if cold weather did not supervene, the male and the oviparous females did not occur at all. With reference to this head De Geer even thought it probable that Aphides living in tropical countries might prove to be wholly viviparous.

De Geer's treatise on Aphides contains the description of eighteen species. It is illustrated by engravings which, though coarse, nevertheless have about them a certain truthfulness of character—particularly those which represent the pseudo-galls on the spruce-fir, which he calls *galle de sapin* and *galle en pomme de sapin*. Except in a slight and general way he does not investigate the phenomena connected with the impregnation of Aphides.

Linnæus, in his 'Systema Naturæ,' briefly describes thirty-three species. In a note made by himself on the margin of his own copy, preserved in the library of the Linnæan Society of London, he remarks that Aphides produce *live* young in the summer, but that in the autumn they lay eggs, adding, "A copula parentum fœcundas nasci filias, neptes, proneptes, abneptes, asseverunt Entomologi." Further on he says that they excrete *honey-dew* ("rorem melleum") from their two posterior cornua, and then he exclaims, "Hæ formicarum vaccæ!" Linnæus does not appear to have made special experiments on *Aphides*, but he notices a few of the more obvious characters of those species which came under his observation. By these descriptions some few species may be well recognised, but now it is difficult to determine from such short notices the identity of other forms he named. The same unfortunate brevity is to be found in the writings of Fabricius when treating on this family. He gives, indeed, little more than details of their general colour and their habitats, omitting altogether reference to the component parts of their antennæ and the varied structure of their wings.

Schrank more exactly describes sixty species, for distinguishing which he relies a great deal upon the relative lengths of the antennæ and the peculiar characters of the tail and cornicles. As his descriptions are too brief to help much in identifying his species, he left much to be accomplished by future systematists. He ascribes too much value to colour, and in a great measure often fails to discriminate between the often

very different forms of the winged and apterous insects.

Schrank was followed by Friedrich Hausmann. Although his notices are somewhat heavy,* he furnishes us with some good and serviceable hints upon which he constructed his seven typical forms. Moreover, he suggests that during the development of Aphides three well-marked life-periods may be traced—*Liebensmomente.*

After this time Zetterstedt paid considerable attention to the neuration of Aphis wings, remarks upon which are to be found in his 'Fauna Lapponica,' but unfortunately, like some of his predecessors, he very generally ignored the characteristic forms and habits of the apterous larvæ. He even brought confusion into the subject by regarding many winged individuals as the males of certain species, although they showed but insignificant differences from the ordinary winged viviparous females of the same kind.

Burmeister set forth good grounds for grouping various members of this family into genera, and in his 'Handbuch der Entomologie' added many new species to those already known. Afterwards, with a view to a better division into genera, Senator Von Heyden separated off, and placed under his new genus Forda, those Aphides which are remarkable for their subterranean habits, and are at the same time furnished with very short antennæ. About this period also the forest-ranger, Herr Hartig, published in 'Germar's Zeitschrift für Entomologie,' Bd. iii, some excellent remarks upon the chief distribution of the nervures or veins of the Hymenoptera generally. In accordance with this plan he constructed nine genera, and described, though in a bald and slight manner, thirty-three species of Aphides. Possibly Hartig's observations and remarks were suggestive to Professor J. H. Kaltenbach, of Aachen, who

* Fried. Hausmann, 'Beiträge zu der Geschichte der Blattläuse.' *Vide* Kaltenbach's 'Introduction,' to which I am much indebted in this summary of early authors; 'Monographie der Familien der Pflanzenläuse,' p. vi, *et seq.*

devised, mainly on the basis of wing-venation, a classification of Aphides which has so far shown its excellence that it is the substratum of most of the modern adopted systems.

In the year 1815 Kyber, the deacon of Eisenburgh, announced those important discoveries which threw increased light on the more special subject of the generation and development of Aphides. His experiments entirely confirmed the earlier observations of Bonnet and De Geer, and gave a fresh impetus to what may be called the physiological side of these researches. Hitherto naturalists had chiefly bestowed their attention on classification and description of species, but Kyber may be said to head a long list of anatomists and able microscopists who, by studying the internal economy of these minute insects, have illustrated and extended our knowledge of the remarkable changes which take place in their development and embryology. Only a few of these authors, however, can here be quoted, though many of their names are illustrious. Amongst these may be mentioned Duvau, who wrote, in the year 1825, on the anatomy of *Aphis fabæ;* and Dutrochet and Burmeister, who followed him in 1835.

Charles Morren in 1836 explained at considerable length the internal organs of *Aphis persicæ*, one of the peach Aphides, which has been since identified with *Aphis dianthi*, Schrank, and also by Professor Passerini with *Rhopalosiphum persicæ*.

Morren's treatise, in many respects, is excellent. He therein describes and figures the many-chambered ovary and adjuncts of the internal reproductive organs of Aphis in a more complete manner than had hitherto been done, but he fell into an error which, having been adopted by other physiologists, has caused much keen criticism and discussion. After noticing the modifying effect of temperature upon these animals he says, "Under ordinary circumstances the female lays eggs when she has wings, and after union with the male, which is winged at the

same time. Thus, deposition of eggs takes place at the seventh generation for some, at the ninth, or even at the eleventh, for others. Before this females only, in the state of larvæ, are born."* The error consists in the assertion that the *oviparous* female is winged. This is denied by Professor Huxley, and it is also contrary to the experience of Kyber, of Kaltenbach, and of Mr. Francis Walker. My own observations also lead me to the conclusion that in all the large section *Aphidinæ* the oviparous female is strictly apterous.† The rule, however, does not obtain in the remote sections *Chermesinæ* and *Pemphiginæ,* the former of which are not known to be viviparous at all. The males of the species comprised in these sections are at present unknown. Morren, later in his memoir, appears to qualify his previous statement, however, for he says of *Aphis persicæ,* "I have frequently seen that the winged and fertilisable female never contained eggs, and never laid them, but that she contained only little living Aphides."

Von Siebold's able memoirs appeared in 1839, and three years afterwards Steenstrup published his celebrated book on the 'Alternation of Generation,' which, by treading on the ground of the doctrine of Parthenogenesis, has had such marked influence on the views of most modern physiologists.

Professor Kaltenbach's excellent treatise, entitled 'Monographie der Familien der Pflanzenläuse,' appeared in 1843. In it he ranges *Aphides* into two great divisions, viz. those which have seven joints to their antennæ and possess wings (Blattläuse), and those which possess less than seven joints to their antennæ, and which, as far as we know, are apterous (Erdläuse). He subdivides these sections respectively into eight and into four genera, taking the wing-veining for a

* Morren's words are, "Dans les circonstances ordinaires la femelle pond des œufs lors qu'elle est ailée, et après un accouplement avec le mâle, ailé à la même époque, &c."—'Ann. des Sciences Naturelles,' 1836, p. 76.

† *Vide, per contra,* Prof. Owen's 'Lectures on the Invertebrata,' 1843.

guide as regards the first set. Again, he ranges the family into what he thought a more natural grouping, dependent upon their supposed different modes of parturition.

1. The vivi-oviparous	Containing the genera *Aphis* and *Lachnus*.
2. The exclusively oviparous	Containing the genera *Chermes, Vacuna, Phylloxera*.
3. The exclusively viviparous	Containing *Tetraneura, Pemphigus, Schizoneura*, and probably *Forda* and *Trama*.

As to the ovo-viviparous character of the first group Kaltenbach truly says there can be no doubt. Observations also, made up to the present time, would lead us to affirm the exclusively oviparous character of the second group ; but with reference to the exclusively viviparous character of the third group even Kaltenbach* expresses some hesitation, and exception now must be taken to it, since some at least of the *Pemphiginæ* are oviparous. Schizoneura and Phylloxera are also certainly oviparous.

Kaltenbach restricts the Linnæan genus Aphis to 158 species, which, again, he subdivides into various headings, to which he simply attaches letters. Some of these smaller groups are, however, sufficiently distinct to induce Koch and later systematists to erect them into genera, after making certain modifications—a procedure which brings the old genus Aphis into a more manageable compass, although it remains still very numerous in species.

Shortly after the appearance of Kaltenbach's monograph Herr Ratzeburg† published a quarto volume, with well-executed figures, on 'Forest Insects and their Injuries to Vegetation.' In this work a considerable space is devoted to the description of Aphides, upon the economy of which he offers some good, but perhaps too diffuse, remarks. He gives an interesting account of the habits of that remarkable Chermes which

* Kaltenbach, Monographie 'Forstpflanzung,' § 4, p. xxv.

† J. J. C. Ratzeburg, 'Die Forst-Insecten,' &c., Berlin, 1844.

sometimes infests the spruce-fir (*Pinus abies*), and constructs, or rather causes, an abnormal growth of very curious pineapple-like excrescences near the axils of the young shoots. However, my belief is, after careful observation, that he unnecessarily splits this species into two. The reasons he gives for so doing, viz. a certain difference in colour, and a slight departure from the usual furcation of the veins on the upper wings, are not to my mind characters of sufficient importance to lead us to suppose otherwise than that these are mere varieties of the same insect. Again, I must express grave doubts as to his discovery of the male of *Chermes abietis* (*C. viridis*, Ratz.). My own observations lead me to the conclusion that this insect is precisely one of those interesting forms in which we might almost believe, though the evidence be but negative, that no male occurs. That such anomalies occur in nature has been distinctly asserted by Leuckart and Von Siebold. Ratzeburg's figure of the presumed male but little differs from the form of the ordinary winged female; and if we may reason from analogy, the bodily proportions given are not those we might be led to expect in the male. Ratzeburg failed to discover any signs of testes or their adjuncts in the specimens he examined. There is some significance in the small spinous processes he draws near the anal region, inasmuch as they closely resemble the double hooklets attached to the very short ovipositor of the allied species, *Chermes laricis*.

In confinement I have bred, during two seasons, many thousand specimens of *Chermes abietis*, but I have uniformly failed to detect, by the microscope or otherwise, a single male amongst the mass. Still, caution should be a text of philosophy. Von Siebold examined microscopically 5796 individuals of the little Entomostracan *Apus*, and failed to discover the male; yet in 1858 the male was proved to exist by Kozubowski. Sir J. Lubbock also examined 193 individuals of *Apus cancriformis* with a similar result; yet, singu-

larly, amongst 72 specimens of *Apus productus*, taken at another time from a pond near Rouen, no less than 33 were proved to be males.

At first Ratzeburg appears to have endorsed Morren's idea that winged male Aphides sometimes paired with winged females, and that the last insect soon afterwards commenced the process of oviposition. He states that he saw such a union take place in May, in a species of Aphis which feeds on the birch, and which has since been identified with *Callipterus oblongus* of Koch. This statement called forth remarks from Kaltenbach and Bouché, both of whom showed that neither ancient nor modern authors have ever proved the occurrence of any sexual union of the male of a true Aphis with any winged female whatever.* More lately Huxley, Walker, and others have asserted the same. Ratzeburg did not afterwards get any confirmation of his observation, but rather leaves one to infer from his subsequent writings that, as regards this particular point, some error might have crept in.

Amongst the early classifiers of Aphides in this country may be mentioned the names of Samouelle, who made a list of forty-one British species, and of William Curtis,† who gave a memoir to the Linnæan Society on the cause of the honey-dew, and described the habits of the large willow Aphis and other species. J. B. Curtis,‡ our well-known entomologist, afterwards proposed to erect some new genera, the characters of which he partly based upon the different positions and modes of articulation of the rostrum. Lastly, amongst English naturalists I may mention the name of my excellent friend the late Francis Walker, who for many years assiduously collected, and in the year 1848 published in the 'Annals of Natural History' a de-

* *Vide* 'Entomologische Zeitung,' 1844, pp. 9–81, 133–410, and also Haliday's translation of note, as quoted by Walker in 'Ann. Nat. Hist.,' vol. i, 1848, p. 259.

† W. Curtis, "Observations on Aphides," 'Linn. Trans.,' vol. vi, p. 75.

‡ J. B. Curtis, 'Journal of Royal Agricultural Society,' vol. vii and others.

scription of one hundred and one species of British Aphides. From time to time he continued to furnish notes on the same subject to the pages of the 'Zoologist' and the 'Entomologist.' In my diagnosis of species I shall make repeated references to these communications.

In the 'Gardeners' Chronicle' may be found various short notices on the ravages of different kinds of Aphides from the pen of Sir Oswald Mosley.

In the year 1857, shortly after the death of the author, appeared a complete monograph by C. L. Koch, entitled, 'Die Pflanzenläuse Aphiden.' In this work every species that came under his observation is illustrated by coloured copperplate figures. These drawings doubtless have a certain value, as they serve to direct the eye towards a general grouping; but as they show no really correct outlines of the insects, and have the common fault of being gaudily coloured, the illustrations must be regarded only as small helps towards the identification of difficult species. Apart from these drawbacks, the monograph is an important one, and is of much value on account of the full descriptions it contains of each insect in its different stages. The treatise is all the more valuable to the student on account of the addition of numerous footnotes from the pen of Professor Kaltenbach.

We need not wonder that such a difficult and variable family as the *Aphididæ* should give rise to somewhat discordant opinions as to what ought to constitute real specific differences amongst them. I believe, although many previously undescribed insects are contained in Koch's long list of 213 German species, that many of the forms he introduces are only variations caused by such external conditions as altered food and temperature. That such conditions have a strong modifying influence on Aphides Kyber* has shown. He remarked that, although the duration of the state of viviparition is in a certain sense almost

* Kyber, 'Einige Erfahrungen und Bermerkungen über Blattläuse.'

unlimited, yet in great measure it is controlled and determined by insufficient food and reduced temperature. Further he says, that certain species, feeding on herbaceous plants which fruit early in the year and then wither, produce males and apterous oviparous females *in the middle of the summer*. Also, that the same thing occurs when the food-plants rapidly become woody in texture. On the contrary, where Aphides get their nourishment from plants persistent throughout the year, the males and the matured females, as a rule, do not appear until *late autumn* or early winter. It is true that Kyber's remarks here particularly refer to the causes which he considers defer the complete development of the cycle by the appearance of those individuals which close that cycle, but it cannot be doubted that the same influences do also affect, within certain limits, the external forms, sizes, and colours of Aphides.

Kaltenbach's grouping of the old genus *Aphis* under indices has been more completely developed by Koch, who threw together a number of allied forms and constructed several genera which have met with general acceptance by modern Entomologists.

Probably the undue multiplication of species and the confusion in the synonymy of Aphis led Prof. Passerini,* of Parma, in 1860, to undertake an entire revision of the subject. He has done good service by tabulating the most marked characteristics of the various genera, and in such a manner that a good clue is afforded the student by which he may satisfactorily track any insect under examination to its correct place in his system. His tables are comprehensive, and such being the case the diagnosis of each species is included within very moderate limits of type. Subsequently to his work on the Italian Aphides he published an alphabetical list of the chief plants he found to be most infested by them, due attention being

* G. Passerini, 'Gli Afidi con un Prospetto dei Generi ed alcune Specie Nuove Italiani,' Parma.

at the same time given to the polyphagous species.* He remarks that, if we know the ordinary food-plant of an Aphis, we may be able with better success to apprehend such minute visible characters as are indicated by the diagnosis. In this way additional weight, for or against, may be given to indecisive features. After pointing out the several researches of Guinani and Barelli, and the work of Gené, of Turin, on noxious insects, Passerini claims credit for Italy, inasmuch as he says she furnished the first platform for operation, from which the march of inquiry has by rapid strides proceeded through Germany, England, and France.

Probably it will be thought that in some cases Passerini has too severely curtailed Koch's list of Aphides, nevertheless the succinct descriptions furnished by his tables form valuable additions to Kaltenbach's and Koch's monographs. Perhaps these three systematic text-books are the best which have yet appeared on the subject.

It would be useless merely to enumerate the names of authors who have with more or less success published papers on Aphides. Some, like Riley in America, have shown that many species common in Europe are also scattered over parts of North America; whilst other authors, like Signoret in France, have proposed classifications based on new characters; but having briefly adverted to the more important works of naturalists who chiefly have devoted their attention to the specific characters, I proceed to mention some of those who have pushed their researches into the more difficult departments of minute anatomy and embryonic development.

First in order amongst British anatomists may be mentioned George Newport,† who in 1846 communicated to the Linnæan Society of London a short paper

* G. Passerini, 'Flora degli Afidi Italiani.'

† G. Newport, 'Linn. Trans.,' vol. xx, p. 281, "On the Generation of Aphides."

the purport of which was to prove that the oval bodies glued to certain plants in autumn and winter were the true ova of Aphides, and not, as had been stoutly maintained by others, modified pupæ. He set the matter at rest by a microscopic examination, through which he established the fact that, like all true ova, these bodies contained a voluminous yolk and a germinal vesicle.

But the most important additions to our knowledge of the reproduction of Aphis made in this country are embodied in two elaborate memoirs written by Prof. Huxley* in 1858. These papers threw new light on the development of the true ova, and of those bodies which he styles the pseudova, organisms which are elaborated from the ovarian chambers of the oviparous and the viviparous females respectively. These memoirs contain descriptions and good plates of the internal reproductive female organs. Mr. Huxley, in concluding these memoirs, points out that there is a close correspondence in all essential respects as regards the embryonic phenomena in the three orders of insects, viz. the Hemiptera, the Diptera, and the Neuroptera.

Again, Dr. Allen Thomson† introduces remarks at some length on the formation of the ovum of Aphis into his article "Ovum" in Todd's 'Cyclopædia of Anatomy and Physiology.' The same subject is discussed by Prof. Owen, both in his lectures on the Invertebrata and in his well-known work on Parthenogenesis. The last author's views were also put into a condensed form in a lecture read to the members of the Royal Institution.‡

The embryology of Aphides is discussed also in the able memoirs and treatises of Von Siebold, Leuckart, Brandt, Claus, Claparède, Mecznikow, Léon Dufour, and others.

* Huxley, 'Linn. Trans.,' vol. xxii, pp. 193–221, "On the Organic Reproduction of Aphis."

† *Vide* article "Ovum" in the Supplement, pp. 34 and 113.

‡ 'Proceedings of the Royal Institution,' vol. i, p. 9.

More recently Balbiani* has given us elaborate and illustrated papers, full of microscopic detail, which bear on the reproductive anatomy of Aphis. His first memoir contains an excellent account of the divided opinions and varied theories of most of the investigators who preceded him. But one chief feature of his recorded observations is connected with the revival of the old idea, started originally by Leuwenhoek, that the apterous and winged viviparous females are hermaphrodite, and that these individuals are capable of self-impregnation.† As in his former treatise, he describes at length the male Aphis and its progressive development from birth to maturity, so in his later memoir, written in 1870,‡ he examines the structure and use of the different organs of the oviparous female, and sets forth the origin of the ovum and the changes which take place in it after its fecundation. He states that all his predecessors had missed the precise characteristics of reproduction in the oviparous female of *Aphis*. Anatomists had asserted that *Aphides*, in their diœcious character, differed in no fundamental particular from insects known to belong to the same class, and that in them existed the same general plan of the reproductive organs; further, that in both cases similar elements were elaborated from them. At the commencement of his third memoir Balbiani states, in opposition to generally received views, "It is sufficient for me to say beforehand that, in showing the facts of a perfectly characterised sexual diœciousness, these facts interweave themselves with circumstances which insuperably bring to mind some of the intimate phenomena of the propagation of viviparous Aphides, and that this mixed character discovers itself even in the organisation of their respective

* Balbiani, "Sur la Reproduction et l'Embryogénie des Pucerons," 'Comp. Rendus,' t, lxii, 1866.

† Balbiani, "Mémoire sur la Génération des Aphides," 'Ann. des Sciences Naturelles,' 15 sér., t. xi, 1869.

‡ Balbiani, 'Bibliothèque des Hautes Études,' "Mémoires sur la Génération des Aphides," Paris, 1870.

reproductive parts. In other terms, I propose to defend this thesis, that the oviparous Aphis partakes at the same time of the phenomena of both ordinary bisexual generation and hermaphroditism, which (latter ?) I consider to be the normal condition of the viviparous individuals of the same species; or, if one prefers it, that they form, as regards their modes of reproduction, a bond of union between these last and other insects."

As might have been expected, these views elicited warm and energetic protests from many quarters. As long ago as 1799 Andrew Knight deduced from his experiments on interbreeding a general maxim, "that it is a law of nature that organic beings shall not fertilise themselves in perpetuity." Mr. Darwin also has most happily urged the same point on the attention of zoologists in his researches on cross-fertilisation. Professor Mecznikow,* in his "Observations on the Homoptera," in Siebold and Kolliker's 'Journal of Scientific Zoology,' gives a concise history of the development of Aphides, and entered the lists foremost amongst the opponents of Balbiani's hypothesis. He was followed by M. Claperède, who endorses Mecznikow's opinion, "that the doctrine of Hermaphroditism amongst Aphides is untenable." I may remark that to me it is not easy to understand how such androgynous characters, if they really existed, could have escaped the acute observation of Von Siebold, Leuckart, Huxley, and other physiologists. Pertinent to this subject, I may be allowed to state that up to the present time I have failed to obtain evidence in favour of Balbiani's special views in any of those species which I have dissected. The subject will again be referred to when the anatomy of the reproductive organs of Aphis comes under discussion.

In closing this short bibliography of Aphis, I will for greater precision quote M. Balbiani's words, lest I

* Mecznikow, "Untersuchungen über die Embryologie der Hemipteren," 'Zeitschrift für Wissensch. Zool.,' t. xvii, 1866.

should misrepresent his meaning. "Il me suffira de dire ici par avance que, tout en présentant des faits de dioicité sexuelle parfaitement caractérisés, ces faits se compliquent chez elles de circonstances qui rappellent invinciblement quelques-uns des phénomènes intimes de la propagation des pucerons vivipares, et que ce caractère mixte se retrouve jusque dans l'organisation de leurs corps reproducteurs. En d'autres termes, je me propose de défendre cette thèse, que les Aphides ovipares participent à la fois des phénomènes de la génération bisexuelle ordinaire, et de l'androgynisme, que je considère comme de condition normale des individus vivipares de même espèce; ou, si l'on aime mieux, qu'ils forment, au point de vue de la reproduction, comme le trait d'union entre ces derniers et les autres insectes."—'Bib. des Hautes Études,' l. c., p. 2.

§ III. LIFE-HISTORY AND METAMORPHOSIS.

Very generally it will be noticed that Aphides abound in such moist and sheltered situations as are unvisited by rough draughts of air. They usually show a preference to the sunny side of a wood, rather than to its northern or eastern aspects. A secluded valley, a ravine with its brook of water, a light thicket on a hanging hill, or the warm side of a hillock with its rank herbage, may be advantageously sought as being the favourite haunts of these insects. But although true that naked heights are but little visited, some species of Aphis are hardy enough to thrive on the stony heaths of Scotland and Northumberland, whilst others will live almost in the reach of the spray of the sea-shore. Thus, *Aphis rumicis* will multiply on several plants which fringe the seaward edge of lofty chalk-cliffs, and Mr. Francis Walker speaks also "of crowds of *Aphides* which he has seen heaped along the sea-shore," doubtless having been previously blown into the water from the vegetation on the adjacent land. The number of species inhabiting a district is found to be governed, as might be supposed, by the varied character of its flora. Some Aphides affect timber trees exclusively; others feed on soft, succulent vegetables and low herbs; others, again, infest the roots of different grasses, or hide under stones and the rotten mortar of old walls. Some aquatic plants are very liable to their attacks. The water-lily, *Nymphæa alba*, sometimes is almost killed by the thousands of *Rhopalosiphum nymphææ* which crowd the leaves; whilst, again, several species infest the reed (*Arundo*) and different sorts of water-cress (*Nasturtium*).

Violent changes of temperature seem much to check the multiplication of Aphides. A cold rain, or the out-

burst of a thunder-storm, will often cause the almost entire extermination of swarms, and wash them, never to return, from their native plants. Nevertheless, the close and hot atmosphere before thunder seems to be peculiarly suited to their propagation. At such times the winged forms occur in great number and take flight on the gentle winds, which transport them many miles to other feeding-grounds, to become the foundresses of other colonies.

Although certain trees and shrubs, as the lime, the privet, the honeysuckle, &c., appear to be attacked exclusively by their peculiar Aphis, other trees give shelter indiscriminately to numerous species. Thus, the oak is infested by at least six, the birch and willow by eight, the elm by four, the fir tribe by eight, and the currant bush by three different species.

Some botanical families appear to be exempt from their attack. For example, no Aphides have yet been observed to feed on the Fumariaciæ, the Gentianæ or the Iridiæ. Professor Kaltenbach considered that no Aphides attacked the Felices or ferns, but the family is not wholly exempt, for I have found, in the greenhouse, a new species which clusters on a foreign *Cystopteris*. As far as I know, our indigenous ferns are not injured in the open air. From the silence of Linnæus, Fabricius, and Schrank on the subject, we might be led to think that the Labiatæ and all cryptogamous plants are free, but Kaltenbach with reference to the first, and Passerini with reference to the last, have proved that both families are injured by at least one species of plant-louse.

The active principles contained in those saps which powerfully affect the functions of warm-blooded animals seem to have no deleterious action on Aphides. On the contrary, the sustenance of some kinds is entirely drawn from such irritant and poisonous juices as are elaborated by *Digitalis purpurea*, *Papaver rhœa*, *Euphorbia peplus*. Even the tobacco plant is laid under contribution by some Aphides.

The duration of some of our flowering plants and annuals is often limited to a few months. Very generally we find that the disappearance of the *Aphides* which peculiarly infest such plants is contemporaneous with their decay; indeed, it would seem to be necessarily so. Yet it is not easy to conceive in what condition these Aphides exist during the rest of the year. There can be no question that some species hibernate, and probably retire under the soil to do so, but this is by no means the rule. On the other hand, oviposition, so far as the *Aphidinæ* are concerned, is confined to late autumn. Even then the process by no means occurs—if it occurs at all—at regular yearly intervals. It will appear to be little better than a guess, that the spring Aphides oviposit early, and that the ova rest in the earth until the return of spring.

MIGRATION OF APHIDES.

The addition of wings to the viviparous females obviously must much facilitate the spread of each species. This modification of form does not occur at fixed or stated intervals, but appears to be in some measure induced by an overcrowded state of the colony, and with a deficiency of food. Gardeners are well aware of the sickly and poisoned conditions produced in those plants which are subjected to the exhausting and irritating attacks of Aphides. When the nutritive juices of the infested plants begin to fail a change commences in the larvæ of those Aphides which are subsequently born. Swellings occur on the sides of the meso- and the meta-thorax, within which the wings of the future imago are developed. These altered forms constitute the pupæ, which often show considerable differences both in markings and colour from the other metamorphic stages. It is to be remarked that, although numerous embryos may be seen in a considerably matured condition within their coverings,

pupæ never give birth to young; this operation is deferred to the appearance of the imago.

Migration seems to take place entirely through the agency of the winged females, just as we find to be the case amongst the ants. Probably through them alone a change in the description of food for the new colony is effected. They alone can select the plants best suited for depositing their young, which, immediately after being dropped by their mothers, commence sucking the sap nearest at hand. My experiments lead me to believe that when once an Aphis has accustomed itself to feed on a particular juice, it will prefer starvation to any change of food-plant, notwithstanding that, on the same spot perhaps, *Aphides* of the same species may be feeding on plants which do not belong to the same natural family. I have repeatedly observed the effect of stinted food in hastening the development of wings, whilst keeping the larvæ in confinement under bell-glasses.

Some naturalists have thought that the often sudden appearance of swarms of winged *Aphides* in early spring may be caused by the action of the nipping easterly winds, which, by checking the flow of sap in the vegetation, remotely produces the same effect on the insects as the stinted food above noticed. To this atmospheric condition, which is usually accompanied by insect swarms and a peculiar haze, the popular voice gives the name of *blight*. Similar conditions of food and climate probably operate to produce the second large migratory flights of early autumn.

Mr. Walker has shown that certain *Aphides* have a true migration from one species of plant to another. Without some such action in their economy we can scarcely see how the insect could prolong its existence beyond the duration of the plant on which it feeds. He affirms that the hop Aphis, *Phorodon humuli*, makes its first appearance on the common sloe, *Prunus spinosa*, and that *Siphonophora granaria* migrates in autumn from the wheat to several kinds of grass. Examples

of migration to be relied on, may be found in *Aphis rumicis*, which has its numerous synonyms from the names of the plants on which it feeds. It passes the autumn and sometimes lays its eggs on the furze, *Ulex Europæus*, and thus it affects this plant both before and after the growth of its more usual food—the broad bean. Notwithstanding these examples of migration, we have no certain knowledge of the winter habitats of numerous species which seem to occur only during a few weeks of midsummer, such as *Siphonophora millefolii*, which may be found from July to September, and then entirely eludes our notice for the rest of the year.

We find much difference in the locomotive and active habits of this family. Some genera, like *Callipterus*, are almost solitary, and rarely move more than one or two inches from the leaf on which they have been dropped, whilst others—more like the Cicadidæ—almost run, and try to conceal themselves from the observer by retiring to the opposite side of the twig.

The walnut Aphis, *Callipterus juglandis*, affects the midrib of the under side of the leaf; but the smaller species, *C. juglandicola*, singularly feeds alone on the upper surface of the leaf. *Aphis cardui*, and others, encrust the flower-stalks of the thistle and other plants, whilst another species covers with their hundreds the yellow spadix, within the spath of the *Arum*. Reference to the great bark-feeding Aphis, *Lachnus quercus*, has already been made. *Chermes corticalis* similarly also draws its nourishment from the rind of the fir-tree.

Finally, various modes of concealment are adopted by different kinds, amongst which may be instanced, as two of the most remarkable, the construction, by *Chermes abietis*, of those conical, or pineapple-like receptacles, which curiously mimic the fruit of the spruce-fir, and the large pseudo-galls formed by *Schizoneura* on the poplar-tree. Less curious are the coloured blisters raised on the leaves of some plants

within which the *Aphides* live, or the tangled masses of foliage often seen on the summits of various native annuals, like *Silene inflata*.

Various devices are employed by *Aphides* to avoid notice. Some will actively run to the opposite side of a branch when danger approaches; others will immediately drop to the ground if disturbed. Some have the curious habit of throwing up their hind legs when alarmed, which action gives a signal to the rest of the colony, which responds by doing the same act. Finally, some of this remarkable family appear to assimilate their colour very much to those of their food, and thus they escape observation. By rolling up leaves, and affecting their under surfaces, protection is gained from sun, rain, and winds, and doubtless then they are less open to the attacks of their many foes, winged and otherwise.

The phenomena of reproduction belong to the domain of physiology, but those of morphology and development belong to that department of natural science which treats of the gradual growth of the individual and the processes connected therewith. Here, therefore, a few remarks upon the latter subject can be best appended.

THE MORPHOLOGY OF APHIDES.

The extreme rarity of the males of some living forms, such as those of the Entomostraca, would seem to prove little more than that the influence of the male element sometimes is exerted at a minimum. That the male in such cases is not *wholly* absent might even show how necessary is the conjunction of primordial cells to perpetuate every species, though such a union may be deferred to very long periods. It may be pretty safely asserted that all Aphides originally proceed from impregnated ova, and at the end of their generations again they produce ova. We are in a

better position for stating this now that the true sexes of twelve or more species are known, and have been satisfactorily made out by dissection.

THE OVUM.

The egg-laying process happens at different seasons of the year according to the habits of different genera. The exclusively oviparous *Chermes laricis* (Chermesinæ) deposits her eggs continuously throughout the spring and summer months, after which she discontinues the process. The last brood—whether impregnated or not is yet uncertain—hybernates and survives the frosts of winter. It wakes to active life in the months of February or March. This hibernation of the foundress of a colony (the Altmütter of Koch) is somewhat exceptional. In almost all other cases (Aphidinæ) the oviparous female oviposits in late autumn and then dies. Usually the appearance of the male precedes by a few days that of the oviparous female, and some short time elapses before the process of egg-laying commences. It has been suggested that the presence of the male acts as a stimulus to the winged female, which stimulus results in the birth of a perfect instead of an imperfect sex. Further researches, however, are required before the existence of such a cause can be asserted as an ascertained fact.

The egg most commonly has the shape of a long oval, the major axis of which is often double the length of the minor axis. The ends are in general equally rounded. At the time of deposition the ova are commonly yellow, or pale ochreous in tint, but after some hours' exposure to the air they often turn to a fine shining black or deep brown. When first extruded they are lubricated by a glairy, tenacious fluid, which acts as a cement, by which the insect attaches them to twigs or the stipules which surround the young buds.

The ova of Aphides are disposed very differently,

both as to number and position. In some species from two to five are glued to a twig, whilst in others clusters are to be found composed of many hundred eggs. In *Chermes laricis* each egg is curiously pedunculated, as we see in Hemerobia, and arranged in tufts covered with the cotton-like fibres torn from the back and sides of the parent.

The large size of the ova of the true *Aphidinæ* is worthy of remark; they sometimes equal one half the length of the female herself. Thus she is incapable of carrying more than four or five in a forward state of development. There are, however, provisions for increasing this number, as the foremost ova are periodically expelled.

Able experimenters have made interesting discoveries as to the remarkable powers possessed by the fecundated egg of resisting intense cold without loss of its vitality. John Hunter exposed eggs of insects to a freezing mixture of ice and salt, and found that, although they solidified at 15° Fahr., they were not destroyed. Spallanzani, again, discovered no loss of vitality by a four hours' exposure to a cold of 38° below zero, and even found that some eggs hatched after subjection to a cold of —56°. Boerhaave noticed that the intense cold of the winter of 1709, in which the thermometer in France fell to the zero of Fahrenheit, in no ways reduced the number of the insects appearing in the following summer. Thus from numerous examples we are led to the conclusion that ova will, without destruction, bear a much lower temperature than the adult animals born from such ova.

From facts like these, however, we must not assume that the intervention of cold weather is the only, or even the chief cause of the appearance of the perfect sexes in this family of insects. On the 12th of March, 1873, whilst the thermometer marked 25° Fahrenheit, and snow was on the ground, I witnessed the hatching of a young Aphis from the eggs of *Siphonophora rosæ*.

The young insect, when free, was lively, and began immediately to crawl about in search of its food. On December 29th of the same year I saw the birth, in the open air, of two young *Aphides* from the winged viviparous female of the same species. She had survived the intense cold of the previous night, in which the thermometer marked 13° Fahrenheit.

Viviparism continued uninterruptedly through the whole winter of 1874 and during the following spring; also I failed to discover a single oviparous female, or one egg of that species. The function of oviposition therefore seems to have little reference to the preservation of any particular species from the rigour of winter, as has been maintained by some entomologists. Some other cause must be sought for the completion of what may be styled the cycle of the compound individual, at which period there would appear to be a necessity for a fresh impetus from the male in order to perpetuate the species.

The vitality of minute insects must strike us with astonishment. What can be the constitution of their living, organised juices, since they thus resist freezing into rigidity and death? It may be assumed that their bodies cannot differ greatly in temperature from the surrounding air, yet their muscles and limbs remain supple and free for locomotion under these extreme conditions. It is certain that some insects are never torpid in winter. Thus *Podura nivalis*, Linn., *Boreas hyemalis*, Latr., *Chionea araneides*, all run and live on the snow. At the other extreme of temperature we have the little entomostracian *Cypris*, which, after many weeks' baking in the hot sun, will recover its activity on being restored to its pool of water.

To give a general idea of the growth of an Aphis from its exclusion out of the egg to the development of the true male and female sexes, it will be well to confine the description here to one species, and the common insect *Siphonophora rosæ* may be taken, as it is persistent throughout the year, and is a familiar form.

The colour of the eggs of Aphides, added to their rarity, renders them often difficult to discover. During the months of February and March, when the leaf-buds of the rose begin to swell, the ova may be seen, like grains of gunpowder, fixed within their crevices of bark. The female attaches these eggs to some varieties only of *Rosa canina* and *R. centifolia*, but occasionally she also affects some of our garden varieties.

A single insect hatched from one of these shining black ova may be the mother of many billions of young, even during her lifetime. Latrielle says one female during the summer will produce young at the rate of about 25 in a day; and Réaumur calculates that one Aphis may be the mother of the enormous number of 5,904,900,000 individuals during the month or six weeks of her existence. Probably the daily birth as given by Latrielle is above the truth, yet I have witnessed the birth of eight young from the same mother in six hours, viz. from ten o'clock in the morning to four o'clock in the afternoon. However this may be, neither Tougard nor Morren is satisfied with Latrielle's billions, but both state that quintillions are within the capabilities of a single mother's efforts. Prof. Huxley makes a curious calculation, though for a different purpose, which at any rate affords some approximate idea of what a quintillion of Aphides might mean. Assuming that an Aphis weighs as little as $\frac{1}{1000}$ of a grain, and that it requires a man to be very stout to weigh more than two million grains, he shows that the tenth brood of Aphides alone, without adding the products of all the generations which precede the tenth, if all the members survive the perils to which they are exposed, contains more ponderable substance than five hundred millions of stout men; that is, more than the whole population of China!*

Facts like these regarding the prolific nature of Aphides afford sufficient explanation of the occurrence

* Huxley, "On Organic Reproduction of Aphis," 'Lin. Trans.,' vol. xxii, p. 215.

of the extraordinary swarms so often noticed by authors. White, of Selborne, remarks on the cloud of "smother-flies" which for several days fell in August, 1785. He says they probably were migrating from the hop-gardens of Kent and Sussex. Again, an immense cloud of winged Aphides, bred in many localities, swept across the river at Gand in September, 1834, and covered the quays and streets of that city. Morren tells us that a learned resident doctor, seeing that the visitation of cholera and of these insects was synchronous, declared that the insects were the immediate cause of the disease! We also hear that the sun was darkened by the same swarm at both Bruges and Anvers. A very large area was thus covered, their march being only limited, we are told, by mountains and elevated plains.*

* The following will show that Professor Huxley's graphic illustration, nevertheless, much under-estimates the real quantity of animal matter capable of elaboration from one single rose Aphis in a year.

Basing the calculation, for simplicity, upon the supposition that every Aphis lives twenty days, and that at the expiration of that period each Aphis shall have produced twenty young and no more, then, at the expiration of three hundred days *only*, the living individuals would be represented by the following figures:

Aphides.		*Days.*	*Aphides.*	
1	produces in	20	$= 20$	$=$ A.
A	"	$40 = 20^2$	$= 400$	$=$ B.
B	"	$100 = 20^5$	$= 3,200,000$	$=$ C.
C	"	$200 = 20^{10}$	$= 10,240,000,000,000$	$=$ D.
D	"	$300 = 20^{15}$	$= 32,768,000,000,000,000,000$	$=$ E.

Again, if 1000 Aphides weigh 1 grain,
and 1 man weighs 2,000,000 grains,
1 man weighs 2,000,000,000 Aphides.

$$\therefore \frac{E}{2,000,000,000} = 1,638,400,000 \text{ men};$$

equal, perhaps, to the population of China sevenfold.

But a mathematical friend remarks that this calculation even does not express the real rate of increase, since it supposes the progeny of the first Aphis to be produced *at once*, and not to commence producing until the expiration of the first twenty days. To this same friend I am indebted for the annexed calculation.

If we suppose the progeny of the first Aphis to equal 20 in twenty days, and this progeny to begin producing when five days old 20 young,

It has been very difficult to remove the error, started first by Réaumur, that Aphides in autumn produce only modified cocoons, and no true eggs. I quote as follows from the article "Aphis" in the 'Penny Cyclopædia,' written at a period so late as 1834:—"Bonnet seems to be of opinion that the Aphides are always viviparous, and never lay eggs; what are commonly called eggs, produced in autumn, being a sort of cocoon consisting of the young Aphis inclosed in an envelope. From our own observation on those of the oak we are convinced that this is the fact; but we cannot affirm, upon negative evidence, that none of the species lay real eggs." It is not easy to guess what the cocoons alluded to might have been. All the more common species of oak Aphis, we now know, lay unmistakeable eggs, and we do not doubt that others do likewise. In autumn some remarkable oval bodies may be occasionally seen, which are covered with a striated, delicate membrane, which gives them somewhat the appearance of a cocoon. These are glued to the leaves of the oak, and often found side by side with the female Aphis full of her eggs. I have been able to watch the hatching of these bodies—for true eggs they are, and their produce is not an Aphis, but the larva of

each of which again on attaining the age of five days begins the propagation of 20 young, and completes also that number in twenty days;

Then at the end of twenty days from the commencement of first Aphis production there would be direct issue .	= 20 A.
At the end of fifth day, progeny A begin to produce, which at the end of first twenty days will altogether equal $15 + 14 + 13 + 12$, &c. $+ 2 + 1$	= 120 B.
At the end of tenth day, progeny B begin to produce, which at the end of the first twenty days will altogether equal $10 + 9 + 8$, &c. $+ 2 + 1$	= 55 C.
At the end of fifteenth day, progeny C begin to produce, which at the end of the first twenty days will altogether equal $5 + 4 + 3 + 2 + 1$	= 15 D.
Total at the end of 20 days equals $A + B + C + D$.	= 210

The amount, therefore, at the end of 300 days (or 20×15) would not be less than the fifteenth power of 210, which is almost impossible to express in figures. "There would be room in the world for nothing else but Aphides!"

a *Syrphus*. It is suggested that these bodies may have misled the above and other authors.

Examples of the mode of grouping ova, either in small isolated patches or in collections of a hundred or more, may be seen in the plates devoted to the species *Siphonophora rosæ*, *Chaitophorus aceris*, *Chermes laricis* and *piceæ*, and *Phylloxera quercus*.

The Aphis just extruded from the egg is not much smaller than the adult, but it shows many differences as to its general contour, the proportions of its antennæ, its cornicles, and its legs. The first of these organs are often in a rudimentary condition. Through a suppression of some of their joints they are usually much shorter than we find in the adult. The last joint is often unformed and very simple. The third joint is the longest, and by its constrictions in certain parts, in after broods, it finally develops the normal number of seven articulations, which full complement, however, occasionally only appears in the winged form. This must be remembered whilst deciding on a genus. The legs of the young insect are very stout and short. The tarsi and claws are large, and the cornicles, if present, have perhaps only a quarter of their normal length. The young, after their emergence from the egg, are active; and as their occupation is to grow as fast as possible, the rostrum, with its enclosed setæ, is fully developed—often, indeed, to such an abnormal extent that it forms an awkward appendage trailing behind the body whilst walking. The young insects will often hatch out in the coldest weather. Very probably light, which is as necessary as heat for the elaboration of both the insect and its food, is here one of the chief stimuli.

As the Aphis grows it assumes more of the normal form of the larva, whilst simultaneously a large increase is to be noticed in the size of the pseudovarian sacs, which begin to occupy the principal part of the abdomen. Development of the germs within these sacs proceeds at different rates, the most forward

being those situated at the apex of the abdomen, from whence they are expelled through the vulva, in an exceptional manner, that is to say, tail foremost.

The young, during birth, have all their extremities disposed parallel to the axis of their bodies, and appear to be lubricated with a fluid which gives as smooth a surface as will permit the antennæ and legs freely to pass point foremost. In *Pemphigus* the fœtus appears to be enclosed in an exceedingly fine membrane, which is cast in the course of a few minutes, after which the limbs extricate themselves one by one. At the time of birth the young rose Aphis exhibits peculiar rapid pulsations throughout the body, during which action air is absorbed into the tracheæ. As these dilate the insect *visibly* grows, and that long before it has taken the least nourishment. Even in this early stage the germs of the next generation may be clearly traced. It is to be remarked that Aphides of the second generation show a small but decided advance in development over those extruded from the egg. The antennæ are longer, and in many cases show an increase from five to six joints. The legs and nectaries are more elongated, and there is also some indication of a tail. As the insect grows, it passes more into the ordinary larval form, minute alterations probably being effected at the time of each moult of skin, at which time the greatest increase of size also takes place.

The number of young Aphides born from a single individual varies with the species, and the same remark applies to the number of broods to be comprised in a cycle. I have counted as many as twenty-five embryos in the body of the female of the viviparous *Siphonophora rosæ*, and all of these were in a more or less forward condition of development. Numerous other pseudova were there to prove that this was far from her limit of reproduction. As to the number of broods, there is a considerable variation also; some species probably are confined to one, whilst other kinds reach to twenty, or, it is stated, to as many as ninety.

Kyber found that the rose Aphis might be kept in its viviparous condition for four consecutive years if its habitat were artificially warmed. During this period of his experiments neither male nor oviparous female appeared. But, notwithstanding so great an authority, more recent facts compel us to the conclusion that temperature alone, as before stated, does not determine the occurrence of these sexes. The duration of life of the viviparous larvæ, on the other hand, is much affected by climatic action. Individuals will live for a considerable time if cold supervenes and checks the rate of their fertility. The larva of the rose Aphis may continue for a month or longer on its own natural feeding-plant, but in confinement I have not preserved them above fifteen days. Stationary habits also would seem to have some effect in prolonging life, since I have observed isolated specimens of *Lachnus pinicola* located on the same twig of larch for two months, during which time no young ones were born.

The spent larvæ of *Siphonophora rosæ* and other species become much pitted and shrivelled from the collapse of their integuments, and at the same time their form becomes elongated. The cornicles or syphons increase much in size, and their curvature becomes more marked. The colour of the insect usually darkens, and the form sometimes is hardly symmetrical, on account of the unequal distension of the sides.

THE PUPA.

There is little doubt that the appearance of the pupa is mainly caused by the necessities of the colony urging upon them a search for fresh food in other places. The viviparous female then gives birth to young, which speedily show a sort of tumescence upon the thoracic regions, from which muscular fasciculi are developed. In conjunction with these thoracic lobes four wing-

cases are developed, two on each side. Slight alterations of colour and form are noticed, the antennæ rapidly increase in length, and usually spots are seen on the occiput which show the seat of the future ocelli. The insect feeds as usual, but after a while it fixes itself permanently by its claws, and continues quiescent for some hours. A rent then commences behind the eyes, which proceeds down the thorax, through which rent the brown head of the imago emerges.

The antennæ and legs are slowly pushed forward from the exuviæ or sheath, which slips down the soft body of the fly by a kind of peristaltic motion very interesting to watch under the microscope. The skin is not inverted, but stands entire, even to the last joints of the antennæ and the tips of the claws—the ghost of its former self. These empty cases may be found by hundreds in the haunts of the rose Aphis.*

THE IMAGO.

When these winged forms first disengage themselves from their chrysalides, they are very pale in colour, and transparent. The wings, at first soft and pulpy, like wet vellum, grow very rapidly; so much so that considerable difficulty is experienced in following with the pencil their outline under the camera. The wings do not unfold themselves, neither do they expand by an inflation of the chief nervures through an introduction of air from the tracheal system. They grow, indeed, in a regular manner, throughout all their parts, and get their full development in the short space of about twenty minutes. This feat of emergence of the imago appears to be almost a mechanical impossibility. It presents one of the most interesting and curious exhibitions of the microscope.†

The moultings of the larvæ, which often are very

* Vide Pl. II, figs. 1—3; Pl. XIV, fig. 3; Pl. XXII bis, fig. 2.

† Sir John Lubbock in his 'Metamorphoses of Insects' interestingly

numerous, are effected in a manner very similar to the above. Kaltenbach thinks that the larvæ commonly take their persistent forms after their fourth moulting of skin. They then begin to multiply, and are from their condition of maturity well suited for description and reference. The young imagos, which have newly emerged from the pupa sheaths, usually exhibit delicate ground tints upon which the markings contrast with much brilliance and sharpness. With age these colours sober down, and sometimes become very dark and suffused. The venation of the wings of the younger flies is also less pronounced in colour. Thus the imago of *Drepanosiphum platanoides* emerges from its chrysalis almost entirely of a bright green, but after the lapse of a few hours, or days, the thoracic lobes become dark, the abdomen becomes barred with black, and the insect shows its adult colours. Examples may be given also in which the pigmented markings finally obliterate the first prevailing ground tints.

The alate females are never so plentiful as the apterous, except at the times of general migration in autumn or spring. Almost every individual then may be found either in the pupal or the winged condition.

Aphides are somewhat heavy in flight notwithstanding their remarkably large expansion of wing. These organs seem to act principally as sails for purposes of suspension in the air. Their chief locomotion is effected by the winds, on which they travel for miles and sometimes at a great height. When preparing for flight the wings are placed at right angles to the body for perhaps a second of time, and then the insects rise with numerous gyrations. *Chermes abietis* throws itself upon its back and spins round violently with a considerable

describes a similar process in the case of certain Ephemeræ, which, whilst under his microscope, required only ten seconds for their extrication from their pupæ. As in Aphis, the imago appears to be separated from the pupa skin by a pellicle of air. A rent takes place in the thorax and the insect walks out, the wings rapidly expand, and flight is taken in an incredibly short time.

buzz before it takes wing from a flat surface. The action is curious, and produces a considerable humming noise when the flies escape numerously from their cones. Shortly after the females have alighted they commence giving birth to living young. In *Chaitophorus aceris* these young form large patches, arranged concentrically to the abdomen of the mother. They may number fifty or more, and scarcely differ in size one from the other.

The winged females appear to be more tenacious of life than the apterous. I have received them alive both from Pembroke and Newcastle, having travelled thence by post inclosed in goosequills. This is by far the best method of transporting them, as the porous character of of the quill prevents their being drowned in their own watery perspiration.

SEX IN APHIS.

Several early observers have erroneously stated that the female Aphis is at different periods of her life both viviparous and oviparous. The acuteness of Newport failed him when he concluded "that Aphides," meaning the same individual Aphides, "deposit at one time true ova and at others produce living young."* He does not tell us on what grounds he decided that the two pupæ of *Aphis rosæ* which he confined for experiment with two oviparous females were males. The subsequent appearance of both ova and living young can easily be explained if any mistakes were made between the winged viviparous female and the winged male. In reality the sex of the latter could only have been decided on with certainty by dissection, to which he does not appear to have resorted. It may be pretty certainly asserted that the viviparous Aphis is never

* G. Newport, "On the Generation of Aphides," 'Linn. Trans.,' vol. xx, p. 281.

oviparous and that the converse also is true. Kyber, many years ago, showed that some species of Aphis carry their viviparous character throughout a period of seven years, so that this mode of reproduction, without union of sex, has been considered by Huxley to be, in a manner, "almost unlimited."

Every new discovery of the perfect sexes of Aphides and other living forms is of interest, as adding evidence to the likelihood of Nature's recurrence to normal phenomena, without which recurrence, probably, no species can be permanent in time. A parallelism surely may be traced in the vegetable world. Horticulturists and pomologists recognise that there is a limit to propagation by simple grafts or buds, at least they see that choice varieties die out, and perhaps never can be reproduced. Recurrence must be made to seed when new characters may appear. So, also, doubts must rise as to the permanence of any animal life without some occasionally renewed seminal influence. Centuries, however, we might conceive possible in certain instances to elapse before the close of a cycle.

Apposite to this Mr. Bentham remarks that, "as Von Siebold, Leuckardt, and others have traced back worms and other parasites through various strange wanderings to an egg derived from a parent similar to itself, so a plant may throw off bulbs, but these sooner or later give rise to seeds or spores which develope into the original form. A *Polype* may produce a *Medusa* or a *Pluteus* or an *Echinoderm*, but the *Medusa* and *Echinoderm* give rise to eggs which produce *Polypes* or *Medusæ;* they are therefore only stages in the cycle of life of the species."* Nevertheless the fact remains of much interest, that myriads of *Aphides* and also of other creatures are brought yearly into existence by a peculiar development; and that the males occur only at such remote intervals that their action seems to exist at a minimum.

* Address to the Linn. Society, May, 1871.

THE MALES.

One noticeable characteristic of this sex is the comparative small size of the abdominal region. This is to be accounted for by the fact that the testes, which occupy the larger portion of the abdomen, are considerably less bulky than the ovarian chambers of the females. In some species the males are very diminutive, but in others the great expanse and breadth of wing add much to their apparent size. Their long antennæ, compound eyes, and stemmata assist them in their active search for their mates. Usually they assume brighter colours than the females, and have fine orange or ferruginous hues strongly marked with brown or black bars and spots. The organs of the mouth are perfect, and the males show no departure from the usual wing neuration of the winged females.

Unfortunately, much confusion has arisen from a neglect of the dissecting needle before deciding upon the sexes of Aphides. Variation from both the winged and apterous females as to size and colour has often led to the assertion that such varieties were males, and in the densely crowded colonies where the insects literally crawl on each other, union of the sexes has been assumed without adequate proof.

The males may be either alate or apterous, but the former condition is by much the most common. Mr. Walker says that the males of *Callipterus tiliæ*, *Chaitophorus salicivora*, and *Aphis pruni* are wingless.* If this be so it would appear that some species of Aphides have both apterous and alate males. It can be proved by dissection that some alate forms of *Callipterus tiliæ* and *Hyalopterus pruni* are males. On the authority of Bonnet and Kaltenbach the male of *Lachnus quercûs* is apterous. Leuckardt says that the male of *Aphis padi* is apterous, but that that sex is winged in *Schizoneura corni*. It is to be remarked that in the family *Coccidæ*

* Walker, 'Ann. Nat. Hist.,' ser. 2, vol. i, pp. 333, 453, &c.; also Kalt., op. cit., p. 166.

the winged condition is that usually assumed by the male sex.

The males and oviparous females often in an inferior degree exhibit the peculiar characteristics of the genus under which they are included. So far as the oviparous females are concerned, they seem to furnish marks of a degraded metamorphosis, just as we observe in the imperfect development of the apterous females of some Lepidoptera, like *Orgyia antiqua* and *Cheimatobia brumata*. In appearance the male usually precedes the female by a few days.

It has been already remarked that temperature alone does not cause the appearance of the males, for some occur in the warm days of September. The heat of summer, on the other hand, does not change the oviparous character of *Chermes* and like genera.

THE OVIPAROUS FEMALE.

This sex is uniformly apterous amongst the Aphidinæ, but it occurs both apterous and alate amongst the Chermesinæ and allied genera. In Aphis proper the oviparous females rarely attain the full size of the viviparous females, but they are characterised by more robust bodies and stouter limbs. The hind tibiæ often are expanded into narrow flattened plates, which probably assist the insects in glueing their ova to plants and bark fissures. Some oviparous forms deviate a good deal from the shape of the larvæ and possess much shorter antennæ, which organs, nevertheless, may contain their full number of joints. Usually the insects are obscurely coloured and do not set forth the ornamental bands and spots to be seen in the males. The absence of stemmata or ocelli indicates their inactive habits and small locomotive powers. The abdomen is bulky, usually from the presence of from five to seven large eggs, which shine through the integument as oval yellow masses. Besides these mature ova, other smaller

ones may be found in the ovisacs ready to supply the places of those which are ripe for extrusion.

DIMORPHISM.

An interesting subject connected with these insects is the tendency shown by some to take double forms. In a certain degree this even may be seen in the contrast between the foundress or first parent (Altmütter) and the individuals of the last brood, just before the process of oviposition commences. The early spring form of *Chermes laricis* is different from that of all her progeny till the last, and the same remark applies also to *Aphis mali* and other species. These variations relate not only to size and colour, but also to considerable change of form and modification of parts. Some such modifications in a smaller degree we find also in the queen wasps, ants, and bees, and markedly so in the *Bombidæ* which survive the winter.

Perhaps the most remarkable example of Dimorphism amongst Aphides is to be found in *Chaitophorus aceris*, the early spring forms of which occasionally are so diverse that they have been described as belonging to not only different genera but distinct families. Thus Mr. Thornton, the original discoverer of this extraordinary insect, gave it the name of *Phyllophorus testudinatus;* afterwards Mr. Lane Clark styled it *Chelymorpha testudo* and placed it between the *Aphididæ* and the *Coccidæ*.*

Another striking example presents itself in the Aphis which causes such terrible destruction to the vines of Southern Europe and those of North America. *Phylloxera vitis* has two entirely different habits of life and form. In one condition it is active and winged, feeding upon the green leaves and shoots of the grape vine, where eventually it oviposits; in the other condition the larva is sluggish, apterous, and lives

* The dimorphism of this insect will be fully described when we consider the genus Chaitophorus in Vol. II of this Monograph.

under ground, where it attacks and oviposits on the young fibriles of the vine roots. These roots soon dilate into knots and knobs, and shortly after they undergo such a complete degeneration that the vine dies. In this manner entire vineyards have been destroyed and capitalists utterly ruined. !?

Future observation may show that other species of Aphis are dimorphous. Should this prove true it will much lessen the difficulty of accounting for the entire disappearance, during several months of the year, of many forms which are now known to feed exclusively on those annuals and plants which die off in early summer. At present we cannot prove the general fact of a migration coupled with dimorphism.

A few remarks may be added upon the geographical distribution of *Aphides*, notwithstanding that our present information unfortunately in this direction is but slight, inasmuch as the family has had but scant attention paid to it, except in the more civilized portions of the world.

As far as we now know, the group is confined to the temperate regions of the globe, but over these regions species are widely spread. Some genera extend far north into cold and inhospitable regions. Thus in the extreme north of Chinese Tartary the Lachninæ are represented by *Lachnus picea;* this insect is also common to the north of Europe, and likewise may be taken on the pines bordering on the glaciers and snow of Switzerland. From the above district of the Amur, Mr. Walker has identified an Aphis, a native of Croatia, *Dryobius Croaticus*, which he thinks (allowance being made for the obscure but undoubted modifications of colour arising from locality) very probably is *Dryobius roboris* of our woods. The same author also has described Aphides collected from China.

Aphides are scattered far and wide over the whole continent of Europe, many species being common in Norway and Sweden, and extending more numerously through France, Germany, and Italy to Sicily.

In Britain hardy species occur on the Scotch mountains, the moors of the Cheviot, the warm slopes of the Undercliff of the Isle of Wight, and amongst the sheltered rocks of the Scilly Isles. In America Professor Riley and Dr. Asa Fitch have described many indigenous species, and also have identified forms common to the continents of the old and new world. The American blight *Schiozoneura*, and the vine Aphis *Phylloxera*, are examples sufficiently obvious to all. Dr. Shimer, in the 'Transactions of the American Ent. Soc.,' vol. i, p. 283, describes under the new genus Hamameliotes, two remarkable species of Aphis, which form obliquely conical galls, and sometimes mimick the form of the fruit of the witch hazel, *Hamamelis Virginiæ,* upon which it feeds. *Pemphiginæ* and other tribes also are natives of British Canada.

It would appear from the statements of Captain Hutton, that no indigenous Aphides can be, or at any rate have been, detected in New Zealand, but that in 1874 imported species were becoming very destructive to the crops. As we approach the tropics, the family Aphis appears to give way to Coccus and Cicada, the external forms of which are very remarkable, and appeal more forcibly to the eye than the less showy Aphis.

Probably we shall hereafter find that the distribution of our British Aphides has followed the march of our Flora, and that the bulk of our insects will be chiefly tracked back to the northern and central parts of Europe.

To assist the reader in naming the Aphides, a general synopsis of the Family has been prepared; and further, a table has been added, of the genus Siphonophora, by which it is hoped some clue, artificial though it be, will be given in a search amongst the species of this somewhat numerous genus. It is purposed to do the same with reference to the genus Aphis, whose members are still more numerous.

SYNOPSIS OF THE FAMILY APHIDIDÆ.

TRIBES			GENERA.
I. APHIDINÆ. Upper wings with a doubly forked cubitus. Lower wing with two oblique veins.	Antennæ with 7 joints		Siphonophora. Phorodon. Myzus. Drepanosiphum. Amphorophora. Megoura. Rhopalosiphum. Melanoxanthus. Siphocoryne. Aphis. Hyalopterus. Cryptosiphum. Chaitophorus.
	Antennæ with 6 joints		Lachnus. Callipterus. Dryobius. Stomaphis. Asiphon.
II. SCHIZONEURINÆ. Upper wing with a singly forked cubitus. Lower wing with two oblique veins.			” ” ” ”
III. PEMPHIGINÆ. Upper wing without a forked cubitus. Lower wing with one or with two oblique veins.			” ” ” ”
IV. CHERMESINÆ. Upper wing without any cubital vein.			” ” ” ”

DESCRIPTION OF PLATE A.

Fig. 1.—Head and rostrum of *Siphonophora circumflexa,* showing *s*, the three stemmata; *e e*, the compound eyes; *o o*, the superposed ocelli; *d*, clypeus; *l*, labrum; *r*, rostral joints; *v*, vertex.

Fig. 2.—Side view of *Siphonophora rosæ.* *c*, coxa; *f*, frontal tubercles; *m*, connecting membranes; *l*, labrum covering the rostral groove.

Fig. 3.—Second, third, and part of the first rostral joints of the same. *b*, protruding setæ. The second joint is perforated, not channelled like the others.

Fig. 4.—Part of the third antennal joint of the male of *Phorodon galeopsidis.* *t*, tubercles; *m*, membranes distended or stretched over the irregular ringed apertures.

Fig. 5.—Sixth, seventh, and part of the fifth antennal joint of the same.

Fig. 6.—Apical portion of the seventh joint.

Fig. 7.—Fourth, fifth, sixth, seventh, and part of the third joints of *Schizoneura Ulmi.* This figure and Fig. 5 show the pseudo-articulations of the sixth and seventh joints. By most authors they are recognised as separate joints.

Figs. 8, 9, and 13.—Portions of the leg of *Aphis pruni.* *f*, femur; *t*, tibia; *c*, tarsus; *u*, claws; *p*, pulvillus, with its contractile ligament; *r* and *x*, flexor and extensor muscles; *m*, membrane connecting tarsus with process of the tibia.

Fig. 10.—Tarsus of *Myzus persicæ,* showing the membrane when the tarsus is extended.

Fig. 11.—Tarsus of *Aphis rumicis,* showing the membrane when the tarsus is contracted.

Fig. 12.—Knee of *Siphonophora rosæ,* showing *s*, the dilating circulatory sac, which pulsates from 120 to 180 times in a minute. The expansions of this sac

extend to the dotted line. A current rises on one side of the leg and returns by the other.

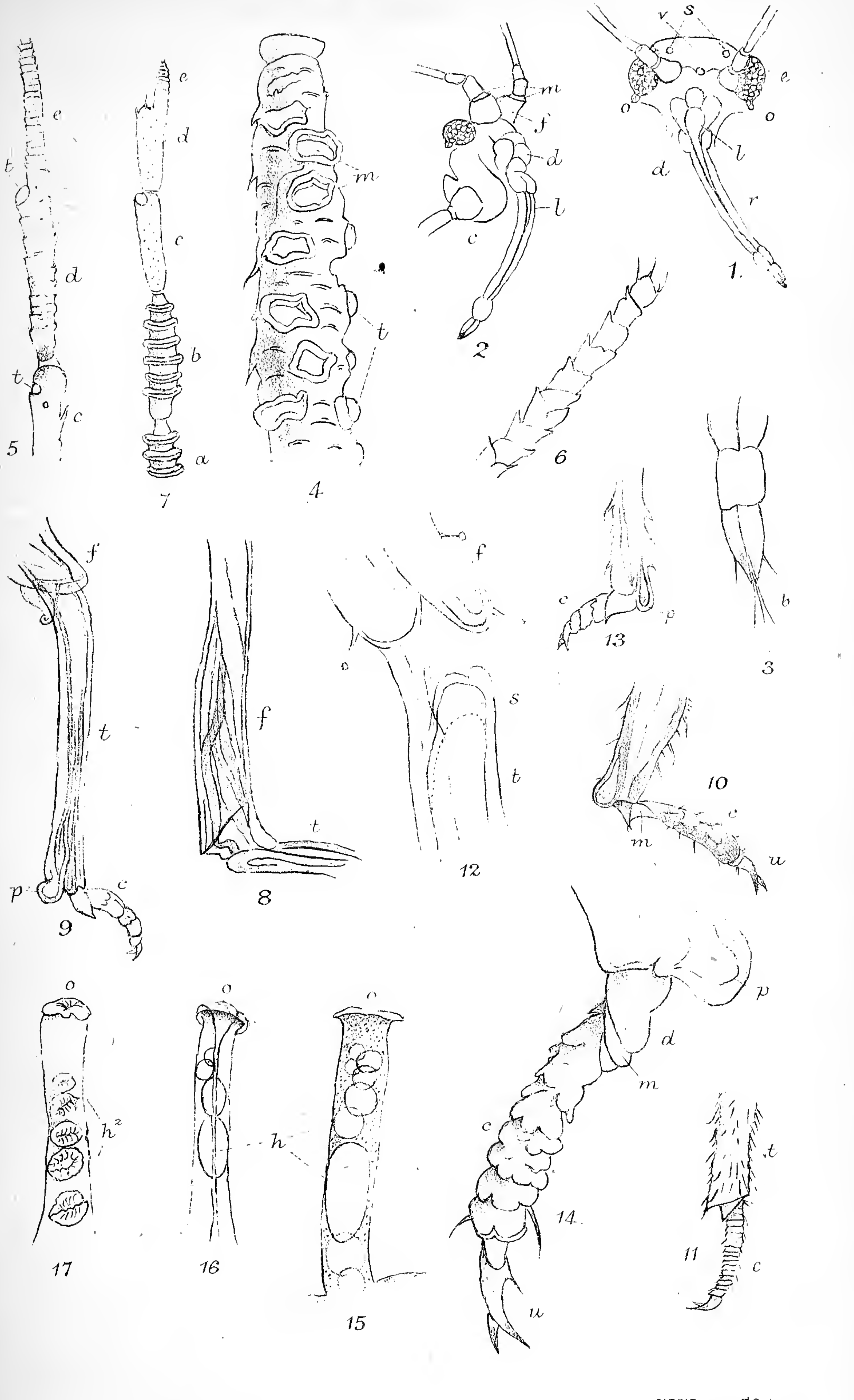
Fig. 13.—Tarsus of *Aphis pruni.*

Fig. 14.—Tarsus of *Phorodon galeopsidis.* *d*, articulating plate; *m*, connecting membrane; *p*, pulvillus; *u*, claws. N.B.—Figs. 4, 12, and 14 have been treated with dilute chromic acid, and viewed by a $\frac{1}{16}$ immersion lens.

Fig. 15.—Cornicle or nectary of *Myzus persicæ*, containing, *h*, several oil-like globules (the air-bubbles of Morren). This substance, when shed, constitutes the "honeydew."

Figs. 16 and 17.—Cornicles of *Siphonophora circumflexa.* The first fig. shows the fine tube which traverses the centres. The latter contains, h^2, several oil-globules which have become semi-crystalline ; *o o o*, the mouths of the cornicles, apparently closed by a membrane.

PLATE A.



G. B. Buckton del. et lith W. West & Co. imp.

DESCRIPTION OF PLATE B.

Fig. 1.—Rostrum of *Stomaphis quercûs.* *l*, labrum; *m*, rostral sheath; *s*, the three long setæ disengaged from the sheath. These are the representatives of the labium and the maxillæ.

Fig. 2.—Head of *Siphonophora pelargonii*, showing the plexus of nerves running to the antennæ, the compound eyes, the ocelli or supplementary eyes, and the parts of the mouth. They all centre in the region at the base of the rostrum.

Fig. 3.—Head and thorax of *Chaitophorus aceris.* *a*, head with stemmata; *b*, prothorax or neck-ring; *c*, mesothorax; *d*, scutum; *e e*, thoracic lobes; *f*, scutellum; *h*, metathorax; *w w*, wing-insertions (pterigostia); *x x*, same of under wings.

Fig. 4.—Under side of *Myzus persicæ.* *a*, head; *b*, prosternum; *c*, mesosternum; *d*, metasternum; *f*, coxæ; *r*, rostrum, resting in its groove *g*.

Fig. 5.— Typical figure of Aphis, after Huxley, showing twenty-three somites, with their appendages, viz. in the head six; in the thorax three; in the abdomen, including the genito-anal portion, eleven. The stomata, typically, are ten in number.

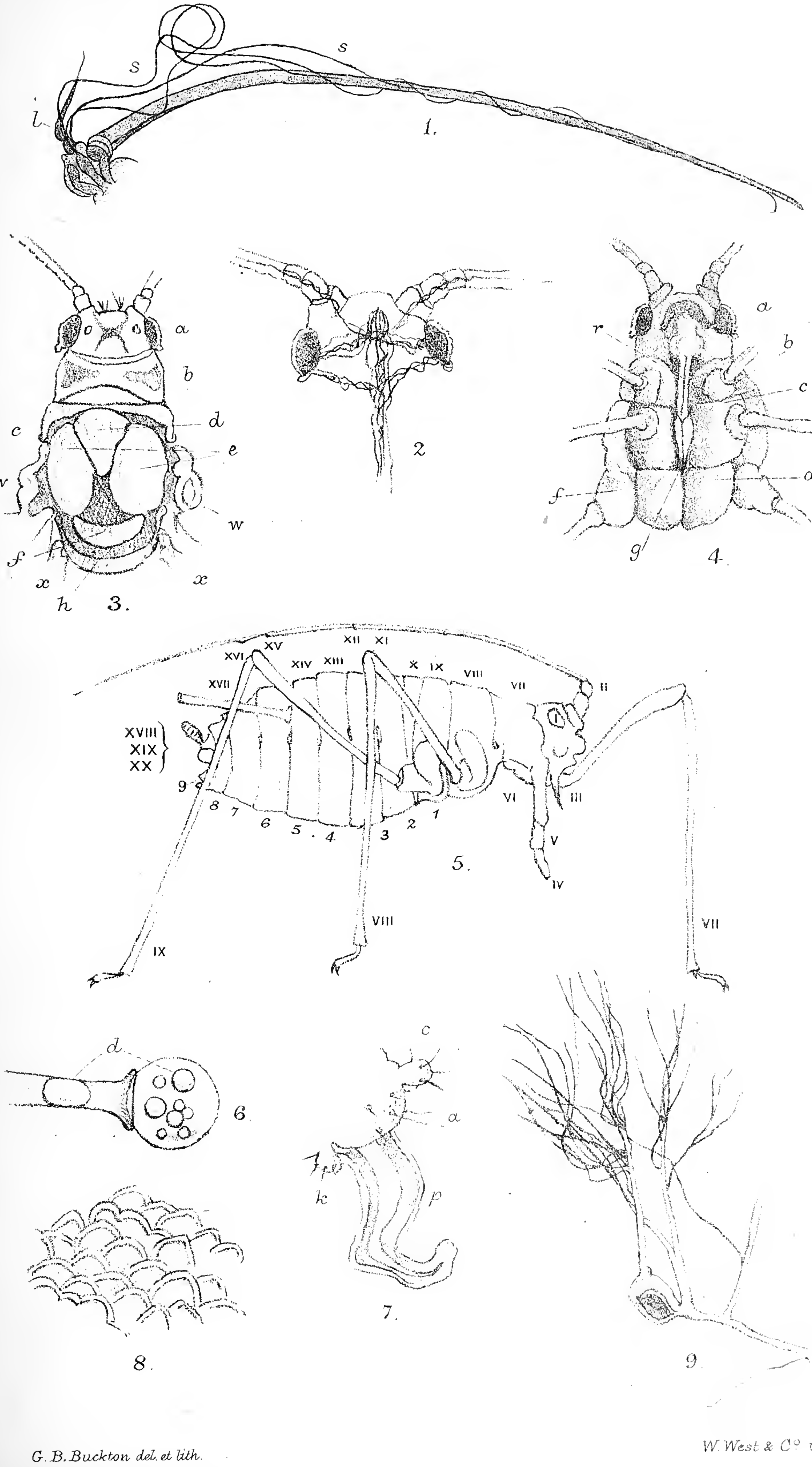
Fig. 6.—Apex of the cornicle of *Siphonophora pisi*, with a globule of so-called honeydew. *d d*, globules of an oily nature floating in an aqueous liquid.

Fig. 7.—Genito-anal portion of the male of *Phorodon galeopsidis.* *a*, anal aperture; *p*, exserted penis; *c*, cauda; *k*, clasping armature.

Fig. 8.—Portion of the imbricated stigma on the wing of *Phorodon galeopsidis.*

Fig. 9.—Stoma and pulmonary chamber of *Siphonophora rosæ* with branching tracheæ proceeding from the same.

PLATE B.



G. B. Buckton del. et lith.

W. West & Cº imp.

DESCRIPTION OF PLATE C.

Fig. 1.—*a a*, antennæ with its nerves running to the plexus in the middle of the head; *e e*, eyes; *o o*, ocelli; *r*, rostrum; *f*, plexus of nerves in communication with the above organs; *l*, nervous filament in the leg produced to the tarsus; *m m*, masses of muscle which act on the pterigostia or wing-insertions *w w*. The muscular fasciculi may be well seen in the thorax of the winged *Siphonophora rosarum* after treatment with acetic acid or dilute alcohol: *g*, œsophagus or gullet; *b*, stomach; *d*, the long and simple intestinal canal filled with numerous pulpy pellets. In some species the gullet walls are roughened by the presence of small intestinal folds or open pockets: *h*, colon partly filled with fæcal matter; *n*, anus; *k*, cauda or tail; *c*, cornicles or nectaries; *s s s*, stomata from which the tufts of tracheæ proceed; *t*, portion of a large air tube which takes a zig-zag direction down the back. To this the ends of the finer tracheæ anastomose.

The drawing probably does not show the exact curve taken during life by the alimentary canal. In some cases it appears to form a double loop, but the folds are difficult to determine.

These details are from *Siphonophora pelargonii*, dissected in syrup.

Fig. 2.—Head and part of the thorax of *Siphonophora dirhoda*, showing the lobe-like masses of salivary glands. Small green vascular fibres may be traced also in the neighbourhood of the rostrum of *Siphonophora rosarum*, which may be referred to the salivary apparatus.

Fig. 3.—Head of *Siphonophora rubi* with similar masses of salivary vessels.

Fig. 4.—Portion of the same drawn under a $\frac{1}{12}$ immersion lens. The looped form of the ducts is

shown. The tubes appear to be cylindrical and of an even diameter throughout.

Fig. 5.—Alimentary canal of *Myzus persicæ*. *g*, gullet; *b*, stomach; *d*, intestine ending in the colon *h*.

Fig. 6.—Portion of the left side of *Chermes abietis*, showing *g g g g*, four glandular organs for secreting the silky matter which invests the insect. The silk issues from numerous mouths disposed in semicircular rows. *t t*, large vessels (tracheal?) passing in the immediate neighbourhood of these glands; *w*, part of the lower wing.

Figs. 7 and 8.—The mouths of similar glands from *Amycla fusiformis*, greatly magnified, showing the silk issuing as a single rod.

Fig. 9.—The rod undergoing a lengthening through a splitting up longitudinally into a flat spiral.

Fig. 10.—Part of tibia and tarsus of the dimorphous form of *Chaitophorus aceris*, showing the flabellæ and prehensile hairs, *h*, in the neighbourhood of the claws.

Fig. 11.—Oil-like globules, largely distributed throughout the body of most Aphides, and particularly crowding near the base of the nectary. On exposure to the air, or on touching with a dilute solution of potash, they crystallize like cystine or margarine, as shown in the figure.

PLATE C.

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I.

APHIDINÆ.

UPPER WING WITH A BIFURCATE CUBITUS.

LOWER WING WITH TWO OBLIQUE VEINS.

(*Zweigabler ; Koch.*)

SIPHONOPHORA

- Apterous form, green
  - Tail yellow in winged female
    - Cornicles black
      - Rosæ.
      - Scabiosæ.
      - Cyparissiæ.
      - Granaria.
      - Lutea.
      - Menthæ
      - Chelidonii.
      - Polygoni.
      - Fragariæ.
    - Cornicles green
      - Body without fasciæ
        - Dirhoda.
        - Pisi.
        - Pelargonii.
        - Rubi.
        - Urticæ.
      - Body with fasciæ
        - Hieracii.
        - Scrophulariæ.
        - Lactucæ.
        - Convolvuli.
      - Body hispid
        - Rosarum.
        - Avellanæ.
  - Tail black in winged female
    - Alliariæ.
    - Millefolii.
    - Circumflexa.
- Colour ferruginous
  - Longipennis.
  - Carnosa.
- Apterous form, brown
  - Tail yellow
    - Body without tubercles
      - Jaceæ.
      - Absinthii.
      - Artemisiæ.
      - Solidaginis.
    - Body with tubercles
      - Tanaceti.
      - Muralis.
      - Tussilaginis.
      - Cichorii.
  - Tail black
    - Tanaceticola.
    - Sisymbrii.
    - Sonchi.
    - Olivata.

Genus I.—SIPHONOPHORA,* *Koch.*

Siphon-aphis. Röhrenlaus.

Rostrum moderately long. Last joint almost as stout as the penultimate.

Antennæ very long—at least as long as the whole body, seated on distinct frontal tubercles. The two basal joints stout and thick. The third, fourth, and fifth joints long. The third joint the longest. The seventh joint setaceous, and much longer than the sixth.

Front grooved. The frontal tubercles approximate.

Cornicles very long, cylindrical, straight, or more rarely curved.

Cauda markedly long, generally recurved and ensiform.

Legs very long and slender.

Wings carried vertically when folded. Fore wings with four oblique veins, the cubital vein twice forked. The hind wings with two oblique veins.

As far as is at present known the males of this genus are winged, and the oviparous females are apterous.

The males usually have smaller abdomens, larger wings, and longer antennæ than the winged females.

1 Siphonophora rosæ, *Réaumer.* Plates I, II, and IV, figs. 1, 2, 3.

Aphis rosæ, Réaumur, Linn., Fabr., De Geer, Schrank, Burm., Kalt., and others.
Siphonophora rosæ, Koch.

* From σίφων a tube, φορέω I bear.

N.B.—The term Siphonophora has been unfortunately employed to denote an order of the oceanic Hydrozoa. Still, between animals so different in structure it is not likely that confusion will arise in nomenclature.

Apterous viviparous female.

	Inches.	Millimètres.
Size of the body	0·130×0·045	3·30×1·13.
Length of antennæ	0·120	3·04.
„ cornicles	0·050	1·27.

Long ovate. Shining green or ferruginous red. Antennæ very long, and springing from large frontal tubercles. Abdomen broadest between the nectaries, usually smooth, but after giving birth to thirty or more young it becomes much puckered or corrugated. Cornicles or nectaries very long, curved and black, dilated at their bases. Cauda large, ensiform, and yellow. Eyes red. Legs long, yellowish-green, with black knees and tarsi.

A red variety is very commonly met with in autumn. It differs much from the green, with which it often intermixes.

The prevailing colour is ferruginous. The body is obscurely ringed with yellow at each junction of the segments. A minute dot marks the stomata and the dorsal pores. The penultimate ring also has a row of four dots, and there is a dark band above the tail.

The figure in Plate II was taken in the open air whilst snow was on the ground on the 11th of January.

At Haslemere* the temperature fell to 12° Fahr. in the month of November, 1871, yet the viviparous female of this species withstood this cold, and I was unable to discover any viviparous female or egg until the January of the following year. This fact would seem to prove that cold alone does not cause the appearance of the oviparous form and the male insect.

The Pupa.

Head rather broad at the vertex. Green, ferruginous about the dorsum, with the four spots on each

* The author's residence, Weycombe, near Haslemere, Surrey, is 583 feet ↑ above sea-level.

lateral edge more marked than the pores near the thorax. Wing-cases brown. The tail little developed. The rest of the insect very like the larva.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·300	7·62.
Size of body	0·095 × 0·035	2·39 × 0·88.
Length of antennæ	0·140	3·55.
,, cornicles	0·025	0·62.

Head, thorax, and thoracic lobes shining black. The prothorax edged with yellow. Eyes red. Antennæ very long, black, and setaceous. Abdomen ovate, shining green, five pore-marks on each dorsal border, and three broad dark marks on each abdominal edge. A black crescentic mark above each insertion of the nectaries, and a larger spot beneath the same. A dark patch on the last abdominal ring. Cauda pale yellow, hirsute. Cornicles black and shining. Legs yellow, with black genua and tarsi. Wing-insertions and cubitus pure yellow. Other veins black. Membrane hyaline.

This specimen was taken January 20th, 1872. During that winter the viviparous females of both kinds continued to breed in the open air, and many pupæ were coming forward, though previously the minimum temperature had been as low as 25° Fahr. During this severe weather the brown variety was very common on the half-evergreen rose bushes. Kaltenbach thinks this red variety might prove to be *Xystus erythrocephalus* of Hartig.

The emergence of the imago from the pupa has been in a general manner described in the section relating to the metamorphosis of Aphis. In Plate II, fig. 2, will be seen a representation of the curious process of exuviation, and also a drawing of the empty and entire skin shed by the insect.

The Male.

There appears to be some discrepancy amongst authors as to the form of this rare insect. De Geer, who seems first to have met with it, does not even tell us whether it is apterous or not. Amongst the companies of Aphides he kept in his chamber, he says that probably he possessed as many as 200 oviparous females. He observed amongst these only "three or four males," which he often saw in union with these females. He remarks that the coitus is long, just as he noticed was the fact in respect of the milfoil Aphis.

Kyber at the beginning of winter introduced a number of males and females into an artificially warmed chamber, and found that the females still continued to oviposit, and never once produced their young alive. He thus showed that if a low temperature could cause, as he thought it could, the appearance of the digenetic forms of Aphides, a warm climate was incapable of producing the converse phenomenon, viz. that of causing the parthenogenetic form, in other words, of converting the oviparous into the non-sexual viviparous character.

Newport performed a somewhat similar experiment, but for a different purpose. He placed four apterous individuals of *S. rosæ* in confinement, two of which he considered to be males. The result of his experiment shows, however, the extreme probability that the latter were only varieties of the viviparous female, which alone will account for the unexpected simultaneous appearance of both eggs and living young.

Mr. F. Walker says that the male of *S. rosæ* is winged, with a black head, dark thorax, and green abdomen.

In this description also Dr. Richardson agrees, and he further implies that the male is always winged.*

Koch observed early in July some small winged Aphides mixed with numerous apterous and larger

* 'Phil. Trans.,' lxi, 121.

winged forms. The former had short antennæ and short legs, and he considered that they were the males. Nevertheless, he says he never saw any union with the other members of the company.

Late in autumn I found associated with the apterous females of this species a small Aphis with disproportionately long wings and antennæ. Its general colour was of a reddish-green, and the apex of the abdomen was furnished with two papillæ, which in the males of *Aphis* constitute the valves attached to the generative organ. Unfortunately, although this insect was carefully drawn, its special anatomical examination was omitted. Nevertheless, there can be no reasonable doubt that this insect, figured in Plate III, is the male of *Siphonophora rosæ*. It closely agrees with the better known males of other species of this genus.

Kaltenbach does not appear to have met with the male. This specimen is the only one that has come under my notice.

Apterous oviparous female.

	Inches.	Millimètres.
Size of body	0·050 × 0·030	1·20 × 0·76.
Length of antennæ	0·025	0·62.
,, cornicles	0·015	0·37.

Long oval. Ferruginous red. Head broad, with a light streak passing from the vertex to the occiput. Eyes red and large. Antennæ remote at their bases, about one third the length of the body. The relative lengths of the joints differ from those shown in the other stages of metamorphosis. The cornicles and legs also are relatively shorter. The hind tibiæ are furnished with numerous tubercular spots, which probably assist the insect in arranging the soft and glutinous eggs in the recesses of the leaf-buds. All the limbs are either of a dark-olive or black colour.

The eggs are at first yellow, but subsequently they become black by reason of certain changes shown by

Balbiani to result from fecundation. Previous to this time the outer coats are sufficiently thin and transparent to allow the process of segmentation to be observed.

The ovum measures about one half the length of the body.

The specimen drawn, Plate II, fig. 5, was taken with several others on December 5th, when the thermometer marked 24° Fahr. Several eggs were laid by them a few days after their capture. Whilst under a microscopic examination one female was watched during the process of glueing her eggs to a twig. The tenacious glutinous coat could be drawn into threads on rolling the same upon a strip of glass.

Notwithstanding the great size of the ovum the female may carry five or more. These, however, are not equally large, but are found to vary in bulk as they approximate maturity and the time for expulsion.

On the Progressive Growth of Siphonophora rosæ.

Only three marked periods of metamorphosis are usually recognised amongst insects. Nevertheless, it is probable that minute modifications of structure, both external and internal, ensue at each moult.

Such moultings are generally very numerous amongst Aphides. Independently of these castings of the exuviæ there can be no question of a slow progression towards the perfect insect, which change becomes very obvious if we compare the insect just hatched from the egg with the young just born alive from any of the later broods. The young born late in autumn are singularly different from those born in early spring, and they may be looked upon as more highly developed. To give a better representation of these changes several figures may be found in Plates I, II, III, and IV, which have been made by the camera lucida.

This well-known species of Aphis infests several

kinds of wild and cultivated rose. They feed on *Rosa canina* and *centifolia*, forming crusts of living lice upon the young shoots and the stalks of the flower-buds. Some of our perpetual roses which partake of an evergreen character are free of this pest, but, on the other hand, the sweet-briar is very liable to its attacks.

The rose Aphis varies so much in form, and occurs of such different colours that it might almost be regarded as Dimorphous.

From the fact that individuals of both kinds freely mix and sometimes unite to form single companies, I think it safer, like other authors, to regard such as mere varieties. Still such variations appear to me to be sufficiently distinct to be described separately under the name of *Siphonophora rosæ*, var. *glauca*.

It has the following characters :

SIPHONOPHORA ROSÆ, *var.* GLAUCA, *Buckton.* Plate III.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·120×0·060	3·04×1·52.
Length of antennæ	0·130	3·30.
,, cornicles	0·045	1·13.

Body long oval; light green or yellowish; covered with a hoary or mealy coating. Antennæ and legs slightly pubescent, shorter than in the insect last described. Prothorax marked with two darker green spots. Abdomen obscurely segmented. Stomata and pores marked by green dots. Tail obtuse. Cornicles cylindrical throughout, dark olive.

Pupa.

Very similar to the larva. Eyes red. Wing-cases olive.

	Inches.	Millimètres.
Size . . .	0·105×0·050	2·66×1·27.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·290	7·35.
Length of body	0·090 × 0·040	2·27 × 1·01.
„ antennæ	0·140	3·55.
„ cornicles	0·035	0·88.

Bright green. Prothorax or collar marked with a dark olive band. Thoracic lobes also dark olive. Abdomen globose and bulky, with four large dark spots on each side. Cornicles dark and cylindrical, as in the larva. Cauda yellowish-green and recurved. Legs wholly green. Wings somewhat coarse, with greenish-yellow post-costal nerves and olive veins.

Parasites.

Although it is not in the scope of this Monograph to attempt anything like a complete list of the parasites which prey upon Aphides, the history of the family would be incomplete without some slight reference to them. Brief notices of the more remarkable insects which keep Aphides in check will, therefore, be made from time to time, and such figures will be added as it is hoped may facilitate their identification.

The larvæ of many predaceous Hymenoptera obtain their sole nourishment from the juices of living Aphides. *Siphonophora rosæ* is very liable to their attacks. These terrible foes go through their metamorphoses within the bodies of both the apterous and the winged females of this species.

These parasites principally belong to the numerous family of Chalcidiæ, a group of the Ichneumonidæ much studied by the late Mr. F. Walker.

Amongst the genera infesting the rose Aphis may be mentioned Aphidius, Allotria, Asaphes, Coryna, Cyrtogaster, and Eucyrtus.

Wherever the rose Aphis is to be found, small, isolated, brown, globular, and apparently lifeless, insects may be discovered upon the leaves. Some of

these will be noticed to be perforated with a round hole, and indeed only empty skins, but others, on crushing under a lens, will be found to contain a small living grub, which eventually would have become a winged Aphidius or one of the like insects.

In June, during the hot weather, I have seen at the same time as many as three of these flies on one rose sprig, each poised on the back of an Aphis, which throws itself into many contortions for the purpose of throwing off its enemy. The ichneumon, however, remains fixed on the back for ten or more minutes before the ovipositor is thrust under the skin of the victim, and the egg is laid. The Aphis appears to suffer at first but little, since it soon resumes its occupation of pumping up the sap. A wormlike, or else more commonly a maggotlike, creature, according to the species of the parasite, hatches from this egg, which revels in the organised nutritious fluid elaborated by the Aphis. The greater part of the abdomen is occupied by this maggot when it becomes full fed, and then it may often be seen through the transparent integuments as a grub curled into a semicircle (*vide* Plate XLIII, fig. 6). In the mean time the skin of the Aphis becomes tense and shining, and then often shows a peculiar plated appearance, as if a number of angular horny plates were united to form the dome of the back. Finally, the Aphis dies, the grub ceases to feed, and after a certain period of rest cuts out of the roof of its prison a circular plate like a trapdoor, as regular in form as if a carpenter's "centre bit" had been used. The emerging fly has four wings, long antennæ, composed of numerous joints, a wasp-like body and legs, and is in every way suited for its marauding expeditions. One of these parasites is represented in Plate IV.

3. SIPHONOPHORA SCABIOSÆ, *Schr.* Plate IV, *bis.*

1801

Aphis scabiosæ, Schr., Kalt.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·130×0060	3·30×1·52.
Length of antennæ	0·140	3·55.
„ cornicles	0·060	1·52.

Large, oblong, bright green, streaked with darker green; or ferruginous mottled with brown. More or less tufted with hair. Front pointed. Antennæ black, with part of third and fourth joints green. Cornicles long, black. Tail about one third the length of the cornicle, luteous. Legs long, green. Femur and tibia tips black. Eyes garnet red. The green specimens are the youngest of the brood, and these are slightly mealy.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·36	9·14.
Size of body	0·100×0·040	2·54×1·01.
Length of antennæ	0·180	4·56.
„ cornicles	0·035	0·88.

Shining yellow green. Head, antennæ, prothorax, thoracic lobes and scutellum, dark brown or black. Abdomen oval and smooth, with three lateral spots on each edge, and three dots on each side of the medial line. A black semicircle, with a larger spot, occurs near the insertions of the nectary. Tail fine yellow and hairy. Nectaries long, cylindrical, and straight. Legs yellow, with black knees and tibiæ. Eyes red. Wings with yellow veins, cubitus, and stigma.

This insect has much resemblance to *S. rosæ;* but there is much difference in the proportion of the legs and wings. The black is confined to the thoracic lobes,

and the marking on the abdomen is not the same. Notice must be taken also of the setose character of the larvæ.

In August the insects cluster round the flower-stalks of the little scabious, *Scabiosa succisa.*

Förster found it feeding also on *Nicotiana rustica.* Kaltenbach rather differently describes this Aphis as marbled with dark and light green, and having antennæ shorter than the body.

There is no doubt of the fact that these last organs increase in length, within certain limits, according to the age of the individual.

Many specimens of this insect were obligingly sent to me by Miss Salvin from Hawksfold, near Fernhurst, Sussex.

4. SIPHONOPHORA CYPARISSIÆ, *Koch.* Plate V.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·100×0·040	2·54×1·01.
Length of antennæ	0·120	3·04
,, cornicles	0·0040	1·01.

Bright green, with a slight mealy coat. A broad, undefined, darker green stripe occurs down the dorsum. Eyes red. Antennæ longer than the body, ochreous yellow, with darker tips. Cornicles very long, black, thickest at the base, curved. Legs fine yellow, knees and tarsi dark brown. Rostrum short.

Pupa.

Pale whitish green, with dark brown wing-cases. The rest like the larva.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·360	9·14
Size of body	0·110×0·045	2·74×1·13.
Length of antennæ	0·180	4·56.
„ cornicles	0·050	1·27.

Large, bright green, shining. Pro-, meso-, and metathorax shining black. Abdomen wholly shining green, without any markings or lateral spots as in *S. rosæ.* Eyes red. Antennæ and legs longer than in *S. rosæ.* Antennæ brown, with the exception of the third joint, which is ochreous. Legs hirsute, ochreous. Tarsi black. Cornicles much curved as in the apterous form. Cauda yellow. Wings ample, iridescent; stigma smoky; veins greenish brown.

This insect is not unlike *Siphonophora rosæ* in colour, but it much differs in its proportion and abdominal markings. Koch found it feeding on *Euphorbia cyparissia.* The only specimens I have seen were feeding on *Scabiosa succisa* and *Rubus fruticosa* in July.

This diversity of food ought to cause no surprise, for observation shows the almost omnivorous habits of several species of Aphis. Thus *Aphis rumicis* feeds on plants of totally different natural orders, such as the bean, the thistle, the furze, the euonymus, &c.

Although this Aphis has not been recorded before as British, I do not doubt, from Koch's description, that it is the insect he thus names.

5 SIPHONOPHORA GRANARIA, *Kirby.* Plate VI.

Aphis granaria, Kirby, Curtis.
— *avenæ,* Fab.? Schrank? Kalt., Walk.
— *hordei,* Kyber.

Aphis cerealis, Kalt.
Bromaphis, Amyott.
Siphonophora cerealis, Koch, Pass.

Viviparous apterous female.

	Inches.	Millimètres.
Size of body	0·100×0·045	2·52×1·13.
Length of antennæ	0·110	2·79.
,, ,, cornicles	0·025	0·72.

Subovate, wholly green or brownish-green. Antennæ brownish. In the adult insect they are as long at least as the body. Frontal tubercles moderately large. Dorsum domed, with marked lateral corrugations. Stomatic pores dark. Nectaries or cornicles shining brown, long, thickened at their bases. Cauda large, yellow, recurved. Legs stout, femora ochreous, tibia points and tarsi black. Eyes red. Rostrum short, reaching only to the second coxæ. First joint greenish, other joints reddish-brown.

Pupa.

	Inches.	Millimètres.
Size of body	0·090×0·050	2·27×1·27.
Length of antennæ	0·080	2·02.
,, ,, cornicles	0·020	9·50.

Subglobose. Usually of a brighter green than the larva. Colour more golden in the autumn. Wing-cases pale brown. Antennæ, cornicles, and legs much as in the larva.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·260	6·60.
Size of body	0·0·80×0·035	2·02×0·88.
Length of antennæ	0·090	2·27.
,, ,, cornicles	0·020	0·50.

Head slightly pointed at the vertex, which is surmounted by one of the three ocelli. General colour

pale brown or rusty yellow. Eyes red. Thorax brown, with oblong and darker coloured thoracic lobes. Scutellum brown. Abdomen ovate, broad, shining green. Dorsum domed, with four well-marked black dots. Lateral carinations obvious, each showing three large black spots in the folds. Cornicles black, long, straight, thickest at their bases. Antennæ longer than the body. Frontal tubercles not largely developed. The first joint thick, and three times the length of the second. Legs ochreous with black genua and tarsi. Cauda yellow, ensiform, and hairy. Rostrum reaches to the second coxæ. Wings ample, with green insertions and dark brown veins; cubitus and stigma pale brown.

This Aphis infests many gramineous plants, but chiefly the wheat (*Triticum*). Schrank found it on the oat (*Avena*), and Koch observed it sparsely scattered on the barley (*Hordeum*). Also he noticed that the larva affects the upper sides of the blade, whilst the winged female attacks the ear. The food plants enumerated by Kaltenbach are, *Secale cereale*, *Triticum sativum*, *Avena fatua*, *Hordeum murinum*, *Bromus mollis*, *Dactylis glomerata*, *Holcus*, *Poa*, and other grasses. Walker adds to these *Glyceria fluitans*, and *Polygonum persicariæ*. Sometimes the flower heads of grasses hang down by the weight of aphides upon them.

Markwick as early as the year 1797 noticed the attacks of *Aphides* on wheat crops. Fabricius gave no description of his *Aphis avenæ;* but Kirby, in his interesting paper, read before the Linnean Society, described probably the same insect under a different name. This name has thus priority over those given by later continental authors, and so I adopt it.

Early in the year the young aphides absorb sap from the blade close to the stem, but later they attack the ears in vast numbers, inserting their rostra close to the junctures of the grains with the stalk. Sometimes as many *Aphides* are present as there are grains in the ears.

Doubtless the injury done is not so much from the quantity of nutritive sap which they withdraw from the plant as from the incessant irritation produced by the punctures of the sucking apparatus. A sickly condition and a yellow colour are soon induced upon the corn plants; but, just as the hop crop is often saved by the appearance of swarms of *Coccinellidæ* and other checks to *Aphides*, so the wheat crop is often saved by the operations of certain minute *Ichneumonidæ* and *Chalcidiæ*.

If the ears of wheat be searched early in the month of July, very probably a number of dead or dying insects will be found fixed singly at the base of each grain, with their heads usually turned downwards. These insects, which are of a rich sienna-brown colour, are the pupæ of *S. granaria* which have been struck by a small, black, winged fly (*Ephedrus plagiator ?*). These parasites may be obtained without difficulty if some of the blighted wheat ears are preserved under a bell glass, when they emerge from the round holes they cut in the Aphis pupæ. They possess attenuated shining bodies, long hairy legs, and many jointed antennæ. The insects appear very large when referred to the empty skins within which they have undergone their metamorphosis.

If the cornfields be again searched a little later in the month, another insect of a different genus will be seen running with excitement over the wheat ears, and tapping with its rapidly vibrating antennæ the pupæ already struck by the *Ephedrus* before mentioned. One of these ears was placed under a microscope of low power for observation. Notwithstanding this novel situation the winged insect, which was identified with *Ceraphron Carpenteri*, Cust,* was too much interested in its work to suspend its operations. After the Ceraphron had satisfied itself that a pupa had not been previously tampered with by one of its own

* *Ceraphron clandestinum*, Nees ab Essenbeck. *Vide* Curtis, 'Farm Insects,' p. 292.

species, it turned the apex of its abdomen towards the abdomen of the Aphis, and then bent the joints of its antennæ so as to form a fulcrum, like a knee-joint, against part of the wheat ear. A fine but short ovipositor was then extruded, and by means of a peculiar sawing motion was finally thrust through the hardened skin of the Aphis pupa. This motion was continued for ten minutes at least, and even after the insect was pierced, during which operation probably the larva of the Ephedrus was stung and made insensible. Finally the Ceraphron introduced its own egg, from the grub of which eventually would come the destruction of the larva of the parasite, which first attacked the larva of *Siphonophora granaria.* This is, in fact, a case of "the biter bit," and we are furnished with an interesting example of one mode whereby the balance of life in nature is sustained. The destruction of one parasite by another here clearly provides against the extirpation of the Aphis in question. The Ephedrus also shows itself a true friend to the farmer; for perhaps twenty or more infested Aphides may be counted on a single ear of wheat.

The pupæ of *S. granaria* are plentiful at the end of July, and the winged females may be taken shortly afterwards and until the crops are harvested.

It cannot be doubted that some species of *Aphides* migrate from plant to plant, and even to different natural orders of plants, but I believe no autumn migration has been observed of *S. granaria.* Bearing in mind the observations on dimorphism in Aphis by Planchon, Pasteur, and Signoret in France, and of Riley, the Professor and State Entomologist of Missouri, I carefully searched the roots of wheat stubble in September so as to discover some possible underground habit of this species. I could find no trace of them around the rootlets, although the aphis had been very plentiful on thr ground during the summer. White cottony tufts were sparsely but generally distributed in the crevices of the soil, from one

to two inches below the surface, but these contained only companies of three or four individuals of *Amycla fuscicornis*, which is entirely a root-feeding species.

There would seem to be no connection whatever between these two species of Aphis, for the latter plentifully occurs throughout the spring on lettuce roots, and at a time when *S. granaria* is feeding on the corn.

Up to the present time no satisfactory answer has been given as to what becomes of the wheat aphis in the winter, neither do we know when the female deposits her eggs.

Koch describes under *Aphis avenæ*, Fab., an insect which differs from his *S. cerealis* chiefly in the shorter character of the antennæ and nectaries. Probably it is a variety only of *S. granaria.*

6. SIPHONOPHORA LUTEA, *Buckton*. Plate VIII.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·065 × 0035	1·64 × 0·88.
Length of antennæ	0·060	1·52.
,, cornicles	0·020	0·50.

Shining bright yellow or greenish yellow, with a dark brown spot upon the dorsum. Antennæ black, but the first and second joints pale reddish. Eyes bright red. Cornicles very stout and thickest at their bases. Cauda long and green. Femora green, with dark genua. Tibiæ and tarsi brown.

Pupa.

Very like the larva, but has no dorsal spot. Wing-cases yellow. Legs rather pale.

Winged viviparous female.

	Inches.	Millimètres.
Expanse	0·230	5·84.
Size of body	0·070 × 0·030	1·77 × 0·76.
Length of antennæ	0·110	2·79.
,, cornicles	0·015	0·37.

Wholly yellow or pale yellowish green. Eyes red. Antennæ longer than those of the pupa. Ocelli red and conspicuous. Thoracic lobes very pale. Abdomen ovate, shining, smooth, with two rows of obscure dots. Cauda yellow. Cornicles long, black, and shining; bases dilated. Legs yellow, with brownish genua and tarsi. Wings slightly fuscous, with pale green insertions; cubitus and stigma green; other veins are fine and black. Rostrum reaches to the second coxæ.

This species was plentiful on several Orchidaceæ in the hothouses of Mr. Smee, at Carshalton, Surrey. He kindly sent me specimens of these in the month of January.

SIPHONOPHORA MENTHÆ, *Buckton.* Plate IX, figs. 1, 2.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·080 × 0·040	2·02 × 1·01.
Length of antennæ	0·100	2·54.
,, cornicles	0·025	0·62.

Long oval, narrow at the head, very broad at the middle of the abdomen. Lively green, transparent, and often permitting the eyes of the embryos within to appear as red specks. Abdomen usually exhibits delicate lines, as if they were the sutures of horny plates. Antennæ very long, slightly olive at their tips. Frontal tubercles very large, and slightly gibbous. Eyes red. Head, thorax, and abdomen consolidated, and without perceptible separation. Cornicles cylindrical, greenish,

and black at the tips. Legs long, hirsute; genua olive; tarsi black. Cauda green.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·260	6·60.
Size of body	0·060 × 0025	1·52 × 0·62.
Length of antennæ	0·070	1·77
„ cornicles	0·015	0·38

Bright green. Antennæ dark olive; the two basal joints green. Eyes red. Thoracic lobes and scutellum olive. Abdomen carinated, with four dark spots within the folds. Nectaries fine and black. Legs green; hardly so long as those of the larva. Tarsi black. The gibbous character of the basal antennæ joints less marked. Wings with pale brown cubitus and stigma.

Some specimens show disjointed transverse bars on the abdomen.

Found rather numerously early in July at Haslemere on the garden mint *Mentha viridis*, and afterwards on the common broom, *Sarothamnus scoparius*.

Passerini says that *Aphis capsellæ* of Kalt. feeds on *Mentha sylvestris*. The description of *A. capsellæ* does not, however, agree with the Aphis above noticed, but the *Aphis menthæ* of Walker possibly might prove to be the same insect.

SIPHONOPHORA CHELIDONII, *Kalt.* Plate IX, figs. 3, 4.

Aphis chelidonii, Kalt.
Siphonophora chelidonii, Koch.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·100 × 0·045	2·54 × 1·13.
Length of antennæ	0·070	1·77
„ cornicles	0·025	0·62.

Long oval, dull yellow or leek green, somewhat

hoary; slightly domed on the dorsum. Antennæ green. Eyes reddish brown. Nectaries or cornicles pale. Tail obtuse and green.

Pupa.

Much the appearance of the larva. Abdominal edges carinated. Usually a darker green stripe occurs down the dorsum. Tarsi olive. Wing-cases the colour of the thorax.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·340	8·63
Size of body	0·090×0·040	2·27×1·01.
Length of antennæ	0·100	2·54.
,, cornicles	0·030	0·76.

Bright green. Head and part of prothorax pale olive. The two thoracic lobes and scutellum dark olive. Abdomen green, and sometimes hairy. Antennæ brownish; the third joint often tuberculate. Eyes red. Cornicles long and thin. Genua, ends of tibiæ, and tarsi brown. Wings large; insertions green, as also are the stigma and cubitus; other veins brown.

Kaltenbach found it feeding on the great celandine *Chelidonium majus*.

The present examples were feeding sparsely under the leaves of the garden raspberry, *Rubus idæus*, from the month of May to October.

Koch remarks that *S. chelidonii* much resembles the Aphis of the milfoil in form. This resemblance cannot relate to its characteristic markings, and must also keep out of view the presence of tubercles on the bodies of the latter insect. Kaltenbach, on the other hand, says *Aphis chelidonii* much resembles *Aphis brassicæ*. Such descriptions well illustrate the difficulties experienced in identifying certain species in this variable family.

SIPHONOPHORA POLYGONI, *Buckton*. Plate X, figs. 1—3.

Pupa.

Small, pale yellow or luteous. Head broad. Eyes red. Antennæ very long. Tips of wing-cases, nectaries, and tarsi slightly olive. Tail yellow.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·260	6 ~~0~~·60.
Size of body	0·070 × 0·030	1·77 × 0·76.
Length of antennæ	0·130	3·30.
,, cornicles	0·020	0·50.

Yellowish or green. Head, prothorax, and thoracic lobes warm brown. Prothorax bordered with yellow. Head broad, ocelli obvious. Antennæ very long. Frontal tubercles not much developed. Abdomen flattened, globose, four or five intercepted bands on the dorsum, with broader spots on the sides. Four marginal spots, and a similunar spot above each nectary. Nectaries black, somewhat tapering. Cauda yellow, and about one third the length of cornicle. Legs yellow, hirsute, with black genua and tarsi. Underside fine yellow, with brown mesosternum and anal valve. Rostrum yellow, reaching to the second coxæ.

The pupæ and winged insects were numerous on *Polygonum persicariæ* at the end of June at Haslemere. At that time I could not find a single apterous larva.

10. SIPHONOPHORA ALLIARIÆ, *Koch*. Plate X, figs. 4—6.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·100 × 0·045	2·54 × 1·13.
Length of antennæ	0·090	2·27.
,, cornicle	0·025	0·62

Long oval, shining, pitted down the sides. Grass-

green, slightly reddish on the head. Antennæ green. Seven minute dark spots on each side, one at the bottom of each dimple. Cornicles long, cylindrical, pale green. Legs hairy, with darker tibia points and tarsi.

Some specimens are reddish green without spots.

Pupa.

Darker green, much corrugated, particularly at the abdominal edges. Head broad. Vertex garnished with bristles. Two small depressions behind the eyes.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·270	6·85.
Size of body	0·090×0·035	2·27×0·88.
Length of antennæ	0·110	2·79.
„ cornicles	0·020	0·50.

General colour dark green. Head shining black. Thoracic lobes and part of prothorax black. Antennæ very long and thin, black throughout. Abdomen oval, with four more or less interrupted dark cross bands on the dorsum, and three large round spots on each side. Two patches of black also between the cornicles, followed by smaller dots towards the tail. Probably these bandings vary by age. Cornicles black. In immature specimens, sometimes these are tipped with yellow. Cauda black and conspicuous. Legs yellow, with darker femora points and tarsi. Wings large; cubitus and insertions yellow; stigma greyish. Rostrum rather short.

Numerous in early June, underneath the leaves of nipple wort, *Lapsana communis*. Koch found it feeding on garlic mustard, *Alliaria officinalis*.

11. SIPHONOPHORA FRAGARIÆ, *Koch*.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·090 × 0·040	2·27 × 1·01.
Length of antennæ	0·100	2·54.
,, cornicles	0·025	0·62.

Whole body shining green except the cornicles, which are tipped with black and straight. Eyes red. Antennæ long and dark olive. Legs pale, with dark femora and tibia joints. Tail yellow.

Pupa.

Reddish-green, with a smoky line down the dorsum. Thorax and wing cases grey. The last with blackish tips.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·350	8·80.
Size of body	0·090 × 0·040	2·27 × 1·01.
Length of antennæ	0·100	2·54.
,, cornicles	0·025	0·62.

Head, thoracic lobes, antennæ, nectaries, tibiæ, and femora points black. All the rest of the body green. Abdomen with four round black spots on each side of the carina, and several obscure marks down the dorsum. Eyes red. Cubitus and wing insertions bright yellow, other veins black. Stigma greyish. Tail yellow. Wholly green on the under side. Some specimens are of a redder shade than the rest.

This insect has much the appearance of *S. alliariæ*, but the tail is yellow and part of the thorax is green.

S. fragariæ is likewise much like *S. rosæ*, but it has no crescentic spots near the nectaries. The resemblance being such, the special coloured figures of this species are omitted.

Koch's description fairly agrees with the English insect, but those I have seen are are not so red as

he states the German specimens to be. Though his figure also is unlike, I do not doubt the identity of the species.

It is remarkable how free certain plants are from Aphides during certain years. I never before the year 1876 saw the garden strawberry attacked, but in June of that year the stalks of the unripe fruit were much infested. Mr. Smee, however, remembers other seasons in which an Aphis was common on the strawberry plant, *Fragaria vesca.*

12. SIPHONOPHORA HIERACII, *Kalt.* Plate XI.

Aphis hieracii, Kalt.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·110 × 0·060	2·79 × 1·52.
Length of antennæ	0·100	2·54
„ cornicles	0·020	0·50

Crowds the flowers and flower-stalks of *Hieracium sylvestre* and *H. murorum.* When taken by me on July 3rd the larvæ had all passed through their preliminary moults, and all the specimens developed shortly into pupæ.

The Pupa.

Very shining, particularly so about the thorax and the wing-cases. Head and abdomen shining dun brown. Thorax dirty green. Upper part of the femora dirty green or yellowish. Antennæ and tibiæ black.

The whole insect is covered with small black tubercles, tufted with fine hair.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·290	7·35.
Size of body	0·090 × 0·030	2·27 × 0·76.
Length of antennæ	0·105	2·66
„ cornicles	0·027	0·52

Smaller than either the larva or pupa. Colour dirty green. Head, prothorax, and thoracic lobes olive brown. Eyes brownish red. First four joints of the antenna green, the other joints black. Abdomen shining, smooth, with six sets of transverse interrupted dark bands. Tail green and pilose. Cornicles greyish green. Legs ochreous, with black femora tips, tibiæ, and tarsi. The whole insect is slightly pilose. Wings with yellow insertions, grey stigma, and fine brown veins.

Kaltenbach speaks of red varieties, having bristly tubercles on the segments.

13. SIPHONOPHORA MILLEFOLII, *Fab.* Plate XII.

Aphis millefolii, Fab., Schr., Kalt., Walk., Koch, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·105×0·050	2·66×1·27.
Length of antennæ	0·140	3·55
,, cornicles	0·020	0·50

Long oval, pointed behind. Pale green or yellow. Head slightly ochreous. Eyes red. Frontal tubercles very large. Antennæ black. The whole body spotted with black, chiefly ranged in transverse rows. Thorax black. Anal rings with black bands. Legs very long, hirsute, and black; femora of first and second pair ochreous. Cauda black and hairy. Rostrum reaches to the third coxæ. The body covered with bristly tufts.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·270	6·87
Size of body	0·100×0·045	2·54×1·13.
Length of antennæ	0·150	3·81
,, cornicles	0·015	0·38

Large. Head black. Frontal tubercles and two

first joints of the antennæ black. Vertex pointed and garnished with bristles. Eyes bright red. Antennæ long, green, darker at the joints and the tips. Prothorax black, with bright green neck-ring. Thorax fine green, with black lobes and scutellum. Abdomen fine green, broad oval, pointed at the apex; medial line with a darker green streak and numerous black transverse dots. Four larger dark green or black spots on the outer abdominal edge, and as many smaller ones near the connexivum. Two semicircular marks near the insertions of the nectaries. Nectaries straight and black. The whole abdomen and the tail studded with tufts of fine hair. Legs long, with yellow femora and black knees. Tibiæ green with black tarsi. Wings moderately long; insertions yellowish green; stigma greyish black; cubitus and other veins dark green.

This prettily marked Aphis is not uncommon at Haslemere from June to the end of September. The winged forms appear early in July, when they, together with the apterous females, crowd within the flower-heads of the common yarrow, *Achillea millifolium*. In September I found the apterous females alone in the flower-heads. On keeping these in confinement, young were produced, which soon changed their colour from green to red, and shortly afterwards developed wing-cases. They all then became pupæ, not of the female but of the male Aphis.

In this species therefore, at least, the males are born from the large apterous females. Naturalists have hitherto thought that the winged females alone produced the males.

The Pupæ of the Males.

These are of various colours, as yellow, brick-red, and fine brown; they are plentifully dotted transversely with black; two large greenish spots appear behind the eyes; the legs are reddish, but otherwise coloured much like the larvæ. The interior of the bodies of

these male pupæ are crowded with numerous oil-globules of a brilliant red colour, which chiefly occupy the anterior portion of the abdominal cavity.

The winged male.

Several of these were bred on September the 27th from the above pupæ, from which I could not obtain a single winged female.

	Inches.	Millimètres.
Expanse of wings	0·260	6·60
Size of body	0·055×0·025	1·39×0·62
Length of antennæ	0·110	2·79
,, cornicles	0·010	0·25

Body much smaller than in either of the female forms. Abdomen attenuated, and measuring but half the length of the body. Head remarkably broad. Eyes brownish red, and large. Antennæ sometimes more than twice the length of the body. Thorax, prothorax, cornicles, femora, lower parts of the tibiæ, and the tarsi dark brown.

The rest of the body orange, or brick-red. The dorsum has three or four cross bands and rows of undefined dots. Three larger spots occur on the abdominal edge. Tail thick, under which the two dark prominent valves appear, which mark the position of the genital orifice. Wings fuscous, with fine yellow insertions and cubitus; stigma greenish; veins brown. The second and third coxæ are very close together and almost touch. Rostrum reaches to the third coxæ.

On crushing one of these insects numerous small bodies disseminated themselves through the weak syrup employed during the dissection. These had gyratory motions, but as I could detect no filaments to these bodies I could not certainly prove that they were sperm-cells, or that the motion was more than that known as "Brownian." The penis, however, was very evident after its extrusion under slight pressure.

The oil-globules noticed above in the pupæ occur

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also in the male. In the apterous female they are of a beautiful green colour. When expressed into water, they assume curious botryoidal shapes, which soon afterwards undergo crystallization, the change commencing from the centre, and finally rendering the whole mass solid.

The oviparous apterous female.

This sex appears usually some few days after the exclusion of the male from its chrysalis. The ova are indeed still rudimentary when the male is fully on the wing. Probably the last insect continues for some weeks to hover over the companies of females.

Balbiani employed this insect most successfully in the study of the organs connected with reproduction. He repeatedly saw the process of oviposition, and was enabled to watch the changes which take place in the egg after fertilization.

He states that by laying the egg in olive oil the outer membrane becomes sufficiently transparent to see the contents; and, further, he says that if air be not excluded by the use of too deep a stratum of oil the vitality of the egg is scarcely, if at all impaired.

14. SIPHONOPHORA CIRCUMFLEXA, *Buckton*. Plate XIII.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·070 × 0·030	1·77 × 0·76.
Length of antennæ	0·075	1·89.
,, cornicles	0·015	0·38.

Oblong oval, smooth, shining. Bright green. Head broad, vertex flat. Antennæ dark at their tips and placed on large frontal tubercles. Thorax deeply pitted, with two black or dark olive spots on each side. Rostrum rather long, reaching to nearly the third coxæ. Abdomen broad between the cornicles.

A dark patch on each side of the first abdominal ring, which is followed by a black characteristic horse-shoe-like mark with an irregular outline. Cornicles green, long and cylindrical. Last abdominal ring dilated. Legs and tail yellow. The last of moderate length. The young Aphides are entirely green.

Pupa.

Wholly green, dull. Two red spots appear behind the eyes, the seats of the future ocelli. Antennæ on large gibbous tubercles. In this respect this species approximates to the genus Myzus. Abdomen much ringed.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·320	8·12.
Size of body	0·070×0·030	1·77×0·76.
Length of antennæ	0·100	2·54.
,, cornicles	0·010	0·25.

Pale green. Head broad. Vertex pointed. Ocelli black. Thorax and pro-thorax black. Eyes and antennæ black. The gibbous character of the frontal tubercles is less pronounced than in the larva. Abdomen oval, anal rings more and more pointed, ending in a black cauda. A small semilunar patch below the scutellum, followed by a row of dots. Below them, a large somewhat triangular black patch, with its obtuse angle pointed backwards. Two last abdominal rings black. Legs fine, with black femora and yellow tibiæ. Cornicles cylindrical and black. Wings very long, with dark grey cubitus and stigmata.

This pretty insect was first noticed in my greenhouse from February to June, on the *Cineraria*, the *Cyclamen*, and the *Spiraxis*. Afterwards in a similar locality it was found plentifully at Chichester. It appears to be a spring species only, and the early winged forms do

not develope such long antennæ, as those which emerge later in June.

15 Siphonophora dirhoda, *Walk.* Plate XIII (*bis*).

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·110×005	2·79×1·27.
Length of antennæ	0·045	1·13.
,, cornicles	0·020	0·50.

Oblong, yellowish green, finely punctured. Antennæ short and rather of a darker green. The frontal tubercles are inconspicuous and so little developed in all the forms that in this respect, and in the somewhat short antennæ *S. dirhoda* approximates to the restricted genus *Aphis*. The vertex is tufted with fine hair. Abdomen rather shining and traversed by two irregular, somewhat waved lines, ranging down the thorax and the dorsum. These green stripes are not equally obvious in all specimens.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0.290	7·35.
Size of the body	0·080×0·030	2·02×0·76.
Length of antennæ	0·070	1·77.
,, cornicles	0·017	0·42.

Green, or yellow green. Head rather olive, with brown stemmata. Thorax yellow, with brown thoracic lobes and scutellum. Abdomen with a cloudy green stripe. Nectaries and tail green. Legs and antennæ pale brown. Wings long. Insertions yellowish brown. Stigma also brown. The rostrum reaches nearly to the second coxæ.

The Male.

	Inches.	Millimètres.
Expanse of wings	0·300	7·62.
Size of body	0·075 × 0·025	1·89 × 0·62.
Length of antennæ	0·100	2·54.
,, cornicles	0·017	0·42.

Like most male Aphides, the wings are disproportionately large, and the tips rounded. Though the body is small the head is large, and wider than the thorax. The abdomen small, and hardly exceeds the length of the head and thorax together. Colour buff, or salmon pink. Head, neck-ring, and thoracic lobes rich brown. The abdomen has eight or more brown dorsal bands, and two corresponding rows of spots on the connexivum. Antennæ longer than the body and brown. The front rather flat, with rather small tubercles. Nectaries buff, as also is the tail. Legs brown, with the exception of the upper halves of the femora. The coxæ are large.

The wings have arched costæ, and all the veins are brown. The stigma is more imbricated than usual.

Apterous oviparous female.

Delicate green. The antennæ rather shorter than the body; slightly darker green at the articulations. Eyes brown. Legs very pale green, almost colourless. The hind tibia much flattened and expanded. The ova usually may be seen through the transparent skin, and are of large size. At such times, the parts near the vulva are dilated into a kind of sac.

This species is not uncommon on the young shoots of the rose, and may be taken at Haslemere from May to November.

Mr. Walker says it migrates to the wheat plant and to various grasses. Also that it may be found feeding on *Polygonum persicaria*. In his catalogue of Homoptera in the British Museum he places *S. rosarum*, of

Koch, under the synomyms of *dirhoda*. This must be an oversight, as the former insect is characterised by small tubercles and numerous tufts of capitate hairs.

Siphonophora dirhoda is not mentioned by either Kaltenbach, Koch, or Passerini. Nevertheless, Walker says, it is sometimes more common in England than *S. rosæ*.

Mr. Walker obligingly sent me, late in November numerous living specimens of males and females from Wanstead. From their transparency they are well suited for studying the internal anatomy.

16. SIPHONOPHORA PISI, *Kalt.* Plate XIV.

Aphis ulmariæ, Schr.
— *onobrychis*, Fonscol.
— *pisi*, Kalt.
— *lathyri*, Walk., Mosley.
Siphonophora pisi, Koch.
— *ulmariæ*, Pass.

Vulgariter. *Green Dolphin.*

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·110×0·050	2·70×1·27.
Length of antennæ	0·140	3·55.
,, cornicles	0·035	0·88.

Large. Colour of many shades of shining green; sometimes, however, mealy and dull, showing the darker green tint below in transverse bands. Long oval. Tail end much pointed. Cauda sometimes scarcely visible. Broad between the cornicles; often six pore marks are to be noticed down the sides of the dorsum. Antennæ very long; each joint ending with a black tip which gives the antennæ a ringed appearance. Eyes brownish red. Cornicles green; partially black or tipped only with black. Tarsi black.

Pupa.

Coloured much as the larva. Wing-cases olive. The mealy coat often reveals a darker green stripe down the back of the insect.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wing	0·360 to 0·380	9·14 to 9·64.
Size of body	0·090 × 0·035	2·27 × 0·88.
Length of antennæ	0·150	1·01.
„ cornicles	0·040	3·81.

Very much of the colour of the larva. More or less glaucous. The antennæ, like the nectaries, slightly vary in shades from pale green to olive. Abdomen very taper. Cauda less ensiform than usual in this genus. Wings ample. Insertions, cubitus, and stigma yellowish green. Thoracic lobes rather olive brown. Rostrum reaches to the second coxæ.

The emergence of the imago from the pupa is an interesting sight under the microscope. The rapid dilation of the insect by the absorption of air is to be noted.

This is one of the most numerous of the field species of Aphides, and in some years is very destructive to the farm crops. It feeds on a large number of plants, but chiefly it infests the field pea, on the young shoots and leaves of which it clusters by thousands. Some years, however, the colonies are few in number. The winged form is less common than the apterous.

Amongst the food plants named by Kaltenbach are *Pisum sativum*, *Lotus uliginosus*, *Lathyrus odoratus*, *Spiræa ulmaria*, *Capsella bursa-pastoris*, &c. The glaucous female in Pl. XIV was taken on the common nettle *Urtica dioica*. Passerini adds *S. gei* to the synonyms of *S. pisi*.

17. SIPHONOPHORA PELARGONII, *Kalt.* Plate XV.

Aphis pelargonii, Kalt.
— *pallida*, Walk.
— *fragariæ*, Walk.?
Siphonophora pelargonii, Koch.
— *diplanteriæ*, Koch?
— *malvæ*, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·060×0·025	1·52×0·62.
Length of antennæ	0·080	2·02.
,, cornicles	0·025	0·62.

Wholly green or yellowish. Long oval, often punctured and wrinkled. Antennæ long, brownish at the tips. Slightly hairy. Eyes red. Cornicles long, cylindrical, and green. Cauda yellowish green. Legs long, with dark tibia tips and tarsi. Rostrum large, reaching to the third coxæ.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·320	8·12.
Size of body	0·080×0·030	2·02×0·76.
Length of antennæ	0·130	3·30.
,, cornicles	0·030	·076.

Green. Head a little dark. Ocelli most usually of the normal number three, but sometimes as many as seven. Eyes red. Antennæ very long, brownish at the tips. Thoracic lobes olive. Abdomen transparent green, often showing the embryos within. Cornicles green, long. Tail green. Legs as in the larva. Wings with pale insertions, cubitus, and stigma. Veins pale brown.

Feeds on various plants. Originally found by Kaltenbach on Pelargonia in greenhouses, but appears now

not to be uncommon in the open air, all through the summer feeding on the *Calceolaria, Geranium* (Koch), *Malva sylvestris*, &c. I have also taken it on *Mespilus germanica.* It appears now to be a hardy species, for it will survive the winter out of doors on the garden *Chrysanthemum* up to December 25th. It is also widely spread, and reaches far north, for the figure is taken from a winged insect feeding on the *Mallow* in May on the Cheviot Hills. In this specimen the ocelli were of the normal number. In the greenhouse *S. pelargonii* continues to produce living young throughout the whole year. I have never seen the male, but Koch notices a flesh-coloured winged variety having a crimson abdomen, which might prove to be that sex.

It is to be noticed that when an Aphis feeds, the tip of the rostrum is pressed against the leaf and the lancets alone puncture the plant. When the proboscis is free, these lancets sometimes protrude considerably beyond the point of the sheath, and then these may be often seen in rapid vibration. This insect is very like *Aphis malvæ*, which, however, differs from the present species in having no frontal tubercles, and showing shorter antennæ and nectaries.

Mr. Walker, I believe, admitted that his *A. pallida* might be identical with *S. pelargonii*, as Passerini has stated.

18. SIPHONOPHORA SCROPHULARIÆ, *Buckton.* Plate XVI, figs. 1, 2.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·080 × 0·035	2·02 × 0·88
Length of antennæ	0·015	2·54
,, cornicles	0·015	0·38

Long oval. Pale ashy, almost white, translucent, pilose. Cornicles cylindrical and straight. Antennæ long and hairy.

Pupa.

Long oval, pointed behind. Pale yellow. Head, wing-cases, and dorsum slightly clouded with grey. Eyes red. First joints of the antennæ gibbous. The whole insect is hirsute.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·290	7·35
Size of body	0·085×0·035	2·14×0·88
Length of antennæ	0·140	3·53
„ cornicles	0·015	0·38

Bright yellow. Head very pale brown. First joints of the antennæ pale and gibbous, like the pupa. Other joints brown. Ocelli conspicuous with a brown mark on the occiput, which becomes broader on the prothorax. Three lobes of the thorax and the scutellum, fine brown. Abdomen rather wrinkled, with four transverse stripes which increase in breadth as they approach the cauda. These are followed by two much broader patches above the cornicles. Cornicles very thin, yellow, straight. Legs yellow, with brown femora points, tibiæ, and tarsi. Tail yellow. Wings moderately long. Insertions and cubitus pale yellow. Stigma greyish. Veins brown. This prettily marked insect was numerous towards the middle of July, at Haslemere, on the common figroot, *Scrophularia scorodonia.* The pupæ were mixed with the winged forms, but at that time I could not find a single apterous female.

Authors have not noticed, I believe, that the *Scrophularia* is infested by Aphides. No such record is made by Passerini in his ‘Flora degli Afidi.’

19. SIPHONOPHORA LACTUCÆ, *Kalt.* Plate XVI, figs. 3, 4, 5.

Aphis lactucæ, Kalt., Walk.
Siphonophora lactucæ, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·075×0·030	1·89×0·76
Length of antennæ	0·070	0·77
„ cornicles	0·010	0·25

Bright green. Some specimens more or less clouded with pink. Long oval. Head and thorax rather broad; distinctly separated from each other. Antennæ green, with paler basal joints. Vertex pointed and tufted. Abdomen domed, wrinkled, and shining, with seven black dots within the edge of the connexivum. Cornicles thin, green, black at the tips. Tail long and yellow. Legs green with black femora points. Tibia points and tarsi black. The posterior rings are pilose. Kaltenbach and Walker state that the cornicles are thicker in their midst.

The Pupa.

Varies much in colour, such as green, brown, or pink. The larva much ringed and shining. Wing-cases green with black tips. The carina of the abdomen green and corrugated. Legs shorter than in the larva or imago.

The pink varieties often have a green dorsal band and faint lateral stripes.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·290	7·35
Size of body	0·090×0·040	2·27×1·01
Length of antennæ	0·080	2·02
„ cornicles	0·015	0·38

Head, prothorax, and thorax shining black, or dark brown. Abdomen green, with six or seven transverse dark bands, the middle band being the broadest. Four lateral spots on each edge. Cornicles green with black tips. Antennæ very long and thin. Legs fine, ochre yellow, with black femora and tibia points. Wings with yellow insertions and greyish stigma. Other veins brown.

The specimen figured contained twenty-four embryos in various stages of development.

This species feeds on many plants, particularly *Lactuca oleracea*, *Lactuca scariola* (garden lettuce), *Sonchus*, *Crepis*, and other plants. It also may be found on the leaves of both *Ribes grossularia* and *Ribes nigrum*. The branching of the wing-veins is somewhat variable, and the length of the antennæ also differs in some individuals.

The insect is commonly met with throughout the whole summer. It does not answer to the description given by Koch of his *S. lactucæ*, which certainly must be a different species.

20. SIPHONOPHORA RUBI, *Kalt.* Plates XVII, XVIII.

Aphis rubi, Kalt., Walk.
Siphonophora rubi, Koch.

Apterous viviparous female.

		Inches.	Millimètres.
Size of body		0·130 × 0·055	3·30 × 1·39
Length of antennæ		0·140	3·55
,,	cornicles	0·050	1·27
,,	cauda	0·020	0·50

Large, shining green, slightly pilose. Long oval. Head narrow. Antennæ and legs long and green. The articulations of the former are slightly marked with black. Eyes brownish red. Cornicles long,

curved, and slightly thickened at their bases; then constricted, inflated at their midst, and finally expanded at their mouths. Cauda large and hairy. Tarsi black.

Numerous during the month of May and June, clustered under the leaves of the bramble, *Rubus fruticosus,* and the wild raspberry, *Rubus idæus.* Later in the year, about the end of July, they are common on the broom, *Sarothamnus scoparius.* Often they may be seen ranged with much regularity on each side of the sutures of the green pods, all their heads being turned in one direction. Walker describes the nectaries as tipped with black.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·4200	10·66
Size of body	0·150 × 0·050	3·04 × 1·27
Length of antennæ	0·170	4·31
,, cornicles	0·040	1·01

Very large. Wholly green, but rather redder on the thorax. Head with conspicuous red ocelli. Antennæ nearly half as long again as the body. Rest of the insect like the larva. Wings iridescent, with yellowish insertions, yellow cubitus and stigma. The whole insect is slightly pilose.

The Male.

	Inches.	Millimètres.
Expanse of wings	0·380	9·64
Size of body	0·100 × 0·040	2·54 × 1·01
Length of antennæ	0·170	4·31
,, cornicles	0·020	0·50

Green. Head very broad and black. Ocelli distinctly marked. Antennæ very long. Back, thorax and prothorax green, with black linear thoracic lobes and small scutellum.

The abdomen very small, not equal to the length of

the head and thorax together. Four or five transverse dark green dashes on the dorsum. Cornicles as in the winged female. Legs disproportionately long. Cauda small. Wings remarkably large. Stigma grey. From the under side, the valves which support the penis can be easily seen.

Some males are redder than the above. Occasionally the wings want the second cubital fork. Also the clavate character of the nectaries is more marked in some specimens than in others.

The males are not uncommon on the raspberry during the month of November. Late also in autumn I received specimens from Wanstead taken on the bramble *Rubus fruticosus*.

The apterous oviparous female.

This measures 0·110 × 0·040 inch. Its form is oval or sac-like, but drawn out towards the head. Green, slightly pubescent. The antennæ and legs are relatively longer in this sex than in the viviparous female, a remark which does not usually apply to other species. As the eggs approach maturity they appear like oval whitish masses under the skin. After deposition and exposure to the air they turn lustrous black.

The oviparous female may be taken at the same time as the male on the raspberry. Occasionally they occur of a ferruginous red colour.

The curved and clavate form of the cornicles make this species approximate to the genus *Rhopalosiphum*. Koch shows this departure from the *Siphonophora* type in his figure of the insect, nevertheless he retains it in the latter genus. I do the same, as in all other respects it best agrees with *Siphonophora*.

Passerini omits *S. rubi* from the list of Italian Aphides possibly from its partial resemblance to *S. urticæ*, a resemblance which Koch notices. The British specimens, however, want the black markings

on the winged female. I regard the insects as quite distinct.

21. SIPHONOPHORA URTICÆ, *Kalt.* Plate XIX.

Aphis urticæ, Kalt., Schr., Walk.
Siphonophora urticæ, Koch.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·130×0·070	3·30×1·77.
Length of antennæ	0·170	4·31.
,, cornicles	0·045	1·13.

This insect is extremely variable both in size and in colour.

Variety α.

Green, carinated, finely punctured, shining. Long oval, attenuated towards the head. Thorax doubly ringed. Eyes reddish-brown. Frontal tubercles very large, approaching to gibbous. Antennæ longer than the body. Usually three dark green irregular stripes appear down the back and sides. Tail and legs wine-yellow or ginger-brown. These with the anal rings are hirsute. Cornicles long and thin.

Variety β.

Dull, somewhat hoary, punctured. No green dorsal or lateral stripes. Not pilose.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	4·440	11·17.
Size of body	0·120×0·050	3·04×1·27.
Length of antennæ	0·230	5·84.
,, cornicles	0·050	1·27.

Very large, shining pea-green. Head, band on prothorax, three thoracic lobes, and scutellum, black. Abdomen ovate, with 3 black lateral spots and irregular dark green dorsal stripe. Cornicles long, thin, and straight, tipped with black. Cauda green. Legs ginger yellow, and hairy. Femora points and tarsi black. Wing insertions pale green. Stigma pale brown. Other veins fine and pale brown.

Numerous on the stinging nettle, *Urtica dioica*.

Walker says it feeds also on *Geranium robertianum*, *Malva sylvestris*, and *Chelidonium majus*. In mild winters it continues to viviparize, and then probably the oviparous female does not make her appearance throughout the whole year.

22. SIPHONOPHORA CARNOSA, *Buckton*. Plate XX.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·130 × 0·060	3·30 × 1·52.
Length of antennæ	0·140	3·55.
„ cornicles	0·040	1·01.

Large. Dark ginger-brown, lilac, flesh-colour, or grey. Hoary, punctured, much corrugated; particularly near the carina or connexivum. Head and thorax broad. Antennæ and legs ginger-brown and hairy. Depressions on the first and second thoracic rings. Carina much marked and wrinkled. Tail brown.

The Pupa.

Smaller than the larva. Most usually of a rosy pink with greenish wing-cases. Carina distinct. The hoary coat more pronounced than in the larva.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·340	8·63.
Size of body	0·100 × 0·040	2·54 × 1·01
Length of antennæ	0·170	4·31.
" cornicles	0·040	1·01.

Large. The imagos on emerging from the pupæ are first of a delicate grey. Afterwards they become green, warm reddish ginger brown, or flesh colour. All the forms are hoary. Ocelli very distinctly marked. A dark patch behind the head. The thoracic lobes are somewhat linear in form, and dark brown like the scutellum. Abdomen with a faint green dorsal stain and green patches at the bases of the nectaries. Wings hyaline with green insertions and brown cubitus and stigma. Other veins are coarse and black. Cauda pointed and green.

The young are very delicate in tint, shading off from white to flesh-colour, to pink, and to yellow. They are often prettily spotted about the head with rose-colour. They run fast, and are much more active than the adult insects.

This insect was found in thousands at Haslemere at the end of June on the stinging nettle, *Urtica urens*. Individuals of the green *Siphonophora urticæ* were very sparsely scattered through the swarms. In this variable family of Homoptera, a common food-plant may suggest the identity of those insects which swarm together, and to a certain extent mix their companies upon it. Whilst caution, on the one hand, will prevent our unduly multiplying species, a true appreciation of structural differences and altered proportions will, on the other hand, save us from ignoring good species. Our conclusions must be based, however, on surer grounds than mere choice of food.

We are not at present acquainted with the causes which operate in the remarkable changes of tints to be seen in some species of Aphides.

Different degrees of oxydation of the nourishing fluids of the animal may partly account for such changes as are connected with climatal action. A reduced vitality may induce chemical changes, just as we find that chlorophyl, the colouring matter of green leaves, will pass through the stages of xanthophyl and erythrophyl to the black tints of decay.

The integuments of Aphides are so thin and transparent, that they readily show the colours of the viscera they contain. Again, the numerous oil-globules, to be found more particularly in the vicinity of the cornicles, are often beautifully coloured, and these materially increase the rich tinting of the bodies of Aphides. These hues, however, must not be confounded with such characteristic marks and distinct bands as are due to the precipitation of pigment within the tissues.

With the exception of blue, I think Mr. Walker gives every colour to *S. urticæ*. I have little doubt that the Aphis I here name *S. carnosa* is included amongst these varieties. Yet *S. urticæ* is a larger insect, the antennæ are disproportionately long, the wings are narrower, the thoracic lobes are more pronounced, and the abdomen is spotted laterally. These points, coupled with the difference in colour, make me think myself justified in separating this insect from *S. urticæ* of Passerini and other authors.

As the ferruginous tint is peristent throughout the summer, I do not ascribe its presence to the action of a low temperature.

Notice will hereafter be taken of the investigation of the colouring matter of some Aphides by Mr. Sorby, who studied the absorption lines brought into view by the spectroscope.

23. SIPHONOPHORA LONGIPENNIS, *Buckton*. Plate XX (*bis*).

Apterous viviparous female.

Form, long oval; much attenuated towards the tail.

Colour yellow, with carnation stains and blotchings. Antennæ green and somewhat short. The pupa is much like the larva.

Pupa.

	Inches.	Millimètres.
Size of body	0·070×0·030	1·77×0·76.
Length of antennæ	0·050	1·27.
,, cornicles	0·010	0·25.

Yellow. Head somewhat broad, with brown spots in the position of the stemmata. Prothorax with a carnation band or ring. Thorax and wing-cases pale yellow, the latter having strongly marked brown tips. Abdomen acuminate. Dorsum stained with carnation. Pore-marks red, with several carnation bands transversely connecting them. Tail yellow. Nectaries green and straight. Legs almost colourless. The femora are nearly as long as the tibia. Eyes red. Antennæ short, green, and seated on inconspicuous frontal tubercles.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·320	8·12.
Size of body	0·080×0·030	2·02×0·76.
Length of antennæ	0·070	1·77.
,, cornicles	0·015	0·38.

This species is remarkable for the great development of its wings. Body almost linear or fusiform. Colour very much as in the pupa, except that the abdomen is free from the red pore-marks and the bands. Thoracic lobes pale yellow. Tail pointed and yellow, about one third the length of the cornicles, which are green, straight, and cylindrical. Antennæ pale green, with darker tips. Frontal tubercles small. Legs almost white, with the tibia and femora of nearly equal length. Eyes red-brown. Stemmata red. Wings ample, hyaline, and greenish, rather corrugated and finely punctured. Insertions, cubitus, stigma, and veins delicate green.

Winged Male.

	Inches.	Millimètres.
Expanse of wings	0·320	8·12.
Size of body	0·070 × 0·022	1·77 × 0·60.
,, antennæ	0·080	2·02.
,, cornicles	0·015	0·38.

Head, thoracic lobes, neck-ring, tips of the femora and tibiæ, rich brown. Tarsi nearly black. Antennæ seated on well developed frontal tubercles, which are somewhat porrected, as in genus Myzus. Abdomen brick-red, with brownish or grey transverse cloudings. Wings longer even than in the winged female.

Taken in some numbers at Norwich in October, whilst feeding on the blades and flower stalks of *Poa annua.*

24. SIPHONOPHORA CONVOLVULI, *Kalt.* Plate XXI.

Aphis vincæ, Walk.

Apterous viviparous female.

Subglobose, green, dull. Two ferruginous patches or stains appear round the insertions of the cornicles. Body punctured, and very transparent. Frontal tubercles large. Joints of the antennæ, tips of the cornicles, and tarsi, black. Tail inconspicuous.

	Inches.	Millimètres.
Size of body	0·100 × 0·050	2·54 × 1·27.
Length of antennæ	0·110	2·79.
,, cornicles	0·025	0·62.

The Pupæ.

These pupæ occur of many shades of green and red. Eyes dark brown. Body punctured. Wing-cases warm brown, antennæ pale. A slight greenish streak sometimes is seen to proceed from the medial line of the dorsum to the tail. Tarsi black.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·260	6·60.
Size of body	0·080 × 0·030	2·02 × 0·76.
Length of antennæ	0·080	2·02.
,, cornicles	0·015	0·38.

Green. Head, band on the prothorax, and mesothorax, shining black. Frontal tubercles somewhat gibbous. Third joint of antennæ serrated. Abdomen ovate, bright green, with a broad black patch on the dorsum, and four cross stripes. Three large lateral spots. Cornicles curved, and slightly thickened in the middle; green, and tipped with black. Legs ochreous, rather short; femoral and tibial tips black. Tail small and green; rostrum reaches nearly to the second coxæ. Wings with pale yellow insertions, and yellow cubitus. Stigma grey. Veins ginger-yellow.

Feeds on *Convolvulus major* and *C. minor, Nemophila,* and *Vinca major.* Taken abundantly in June at Chichester and at Haslemere.

The antennæ of the winged insect are proportionally shorter than those of the apterous female. This is an inversion of the usual measurement.

25. SIPHONOPHORA AVELLANÆ, *Schr.* Plate XXII.

Aphis avellanæ, Schr., Walk.
,, *coryli*, Sir O. Mosley.
Siphonophora avellanæ, Koch., Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·070 × 0·040	1·77 × 1·01.
Length of antennæ	0·100	2·54.
,, cornicles	0·025	0·62.

Very pale green, shading into reddish-green towards the head. Head very broad. Frontal tubercles large.

Vertex tufted. Abdomen oval, furnished with small tubercles, each tufted with fine bristles. Dorsum rough. Antennæ long, pubescent, pale brown. Cornicles very long, cylindrical, pale green. Tail small. Eyes brown. Legs pale brown and hairy.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·280	7·10.
Size of body	0·070 × 0·035	1·77 × 0·88.
Length of antennæ	0·110	2·79.
,, cornicles	0·025	0·62.

Pale green. Often tinged with brown between the cornicles. Head, first two joints of the antennæ, three lobes of the thorax, and scutellum, dark brown or black. Cornicles and legs as in the larva. Tarsi black. Wings with warm brown stigmata, and brown veins. Passerini says the cornicles are tipped with black.

Found throughout the year, sparsely scattered under the leaves of the hazel, *Corylus avellana*. The winged female appears up to the end of August. This Aphis does not seem to have come under the personal observation of Kaltenbach.

The young Aphis is almost white.

96. SIPHONOPHORA ROSARUM, *Walk.* Plate XXII (*bis*).

Aphis rosarum, Walk.
Siphonophora rosarum, Koch.

Apterous viviparous female.

	Inches.	Millimètres.
Size of the body	0·070 × 0·035	1·77 × 0·88.
Length of antennæ	0·050	1·27.
,, cornicles	0·015	0·38.

Long oval, flat. Wholly green, ringed, the posterior edges fringed with capitate bristles, which mostly

spring from small tubercles. Vertex tufted. Antennæ and legs somewhat short. Frontal tubercles small. Eyes reddish-brown. Tail green and not conspicuous.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·240	6·09.
Size of body	0·070×0·025	1·77×0·62.
Length of antennæ	0·070	1·77.
,, cornicles	0·015	0·38.

Green, not bristly. Head and thoracic lobes black. Abdomen with six or more black transverse bars, decreasing in length and breadth towards the apex. Four lateral spots on each side. Cornicles green and cylindrical. Tail green. Legs somewhat short, green, with black femoral and tibial points. Wings rounded, with warm blackish veins, which are slightly expanded at their outer margins. Cubitus greenish. Stigma grey and imbricated. Third joint of the antennæ shows a tendency to become ringed. Only the legs and antennæ are pilose, and the hairs are non-capitate. Eyes red. Rostrum reaches to the second coxæ.

Some years plentiful on the sweet briar and the dog-rose about Haslemere.

The *Aphis rosarum* of Kaltenbach is described by him as having no frontal tubercles, and being hairless. As the vertex is not pointed, he says this insect should not be placed in Siphonophora. I believe it to be a different insect.

SIPHONOPHORA TANACETI, *Linn.* Plate XXIII, figs. 1, 2.

Aphis tanaceti, Linn., Kalt.
Siphonophora tanaceti, Koch.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·070×0·040	1·77×1·01.
Length of antennæ	0·085	2·14.
,, cornicles	0·017	0·43.

Globose, flat, shining. Warm dark brown. Head blackish, broad. Eyes coral-red. Thoracic rings with fine yellow edges. Abdomen domed and carinated, rather shining. The carina yellow with reddish stains. Two dark dots above the thorax. Cornicles black, fine, and straight. Tail reddish-black, obtuse, hairy. Antennæ long, fixed on small frontal tubercles, black, and hirsute. Legs short, wholly black, hairy. Hind tibia curved. Underside yellowish-brown with dark coxæ and anal plate. Rostrum reaching to the third coxæ. This insect stains Canada balsam a fine red colour.

Taken by Mr. Walker at the Isle of Wight, September 8th. It feeds on the Tansy, *Tanacetum vulgare*.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·340	8·63.
Size of body	0·100 × 0·047	2·54 × 1·23.
Length of antennæ	0·130	3·30.
,, cornicles	0·030	0·76.

Large. Head and thorax brown. Antennæ rather shorter than those of the species last described. Abdomen broad, without tubercles, reddish-brown, with a darker patch above the cornicles, and four smaller spots at the outer edges. Cornicles thin, straight, and black. All the legs black and hirsute. Tail short and yellowish. Insertions of the wings yellow. Cubitus and veins pale, the last fine. Stigma greenish.

The specimen from which the figure is taken was found with others on *Lapsana communis* in June. At that time I could not find a single wingless female in company. The English insect slightly differs from Kaltenbach's description. The antennæ of his insect are longer, and the body is dark green and marbled with black.

28. SIPHONOPHORA JACEÆ, *Linn.* Plate XXIII, figs. 3, 4.

Aphis jaceæ, Linn., Kalt.
Siphonophora jaceæ, Koch.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·100×0·050	2·54×1·27.
Length of antennæ	0·100	2·54.
,, cornicles	0.035	0·88.

Head broad. Whole insect dark brown, with a greenish lustre. Thorax and prothorax distinctly separated from the head. Abdomen oval, pointed behind, furnished with seven or eight shining and tufted tubercles. Antennæ black, not very long. Eyes brown. Cornicles large and black. Legs somewhat short. All parts black except the half of the femora near the coxæ. Tail dark brown.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·340	8·63.
Size of body	0·150×0·060	3·81×1·54.
Length of antennæ	0·170	4·31.
,, cornicles	0·050	1·27.

Very large. Shining brown, with a brassy metallic glance. Hirsute, but without tubercles. Head and thoracic region narrow. Eyes large and brown. Antennæ very long. First joint thick. Thoracic lobes dark brown. Abdomen very large, oval, smooth, and shining. Clothed with fine hair. Cornicles long, straight, and thin. Usually carried at right angles to the body. Cauda thin, pointed, and black. Legs very long. Hind tibiæ much curved. With the exception of half the femora all the limbs are black. Wings very short for the size of the insect. The insertions,

cubitus, and stigma, fine yellow. The other veins very fine, and pale brown. Rostrum short, not reaching to the second coxæ.

Numerous on the sow-thistle, *Sonchus oleraceus*, at Haslemere, in August. The figures in Plate XXIII are of relative sizes.

29. SIPHONOPHORA ABSINTHII, *Linn.* Plate XXIV, figs. 1, 2.

Aphis absinthii, Linn., Walk., Kalt.
Siphonophora absinthii, Pass.

	Inches.	Millimètres.
Size of the body	0·080 × 0·035	2·02 × 0·88.
Length of the antennæ	0·075	1·89.
,, cornicles	0·012	0·30.

Long oval, shining, dark brown, pilose, with small tubercles. Slightly powdered with white. Frontal tubercles small. Eyes red. Legs and cornicles rather short, brown. Tail rather obtuse.

Numerous in August under the leaves of the wormwood, *Artemisia absinthium*. They were taken at Wanstead by the late Mr. Walker, and were identified by him as his *Aphis absinthii*. Although numerous larvæ came into my hands I failed in obtaining the winged female from them.

Mr. Walker, in the 'Annals of Nat. Hist.,' ser. ii, vol. ii, p. 43, gives a long list of synonyms, some of which I must think are doubtfully correct.

Kaltenbach describes the winged female as black, shining, and having a brownish abdomen spotted much like that of the larva. The wings are pale and the costa brownish-yellow. He says that individuals of this species are often mixed with those of *Aphis tanacetaria*.

Koch's figure of *S. absinthii* is very unlike my insect.

0. SIPHONOPHORA ARTEMISIÆ, *Koch.* Plate XXIV, figs. 3, 4.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·100 × 0·060	2·54 × 1·54.
Length of antennæ	0·110	2·79.
,, cornicles	0·015	0·38.

Globose. Head and thorax attenuated. Colour rich shining brown. The head, antennæ, and legs, black, as also are the nectaries and tail. The whole body is finely tufted with brown hair. Several interrupted lines on the dorsum run together, so as to form a dark patch; and black bars also occur on the lateral edges of the abdomen. Eyes red.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of the wings	0·300	7·62.
Size of body	0·085 × 0·035	2·14 × 0·88.
Length of nectaries	0·130	3·30.
,, cornicles	0·015	0·38.

Wholly shining black, and covered with a scanty brown pubescence. A blackish patch occurs on the dorsum as in the larval form. Antennæ very long. Eyes reddish-brown. Legs, nectaries, and tail, black.

The wings have brownish membranes, with fine green insertions. Stigma olive-green. Other veins pale brown.

The rostrum reaches to the third coxæ.

The pupa is very like the larva, but it has a greenish thorax and brown wing-cases.

Specimens were kindly sent to me by Mr. Chas. Barrett, who found the insects crowding the flowers of the mug-wort, *Artemisia vulgaris.* They travelled well in quills from their habitat near Milford Haven, in South Wales.

This insect is not *Aphis artemisiæ* of Fonscolombe which Kaltenbach identifies with his *Aphis tanaceticola*. He describes it as green and not unlike *S. millefolii*.

Several Aphides seem to feed on different species of Artemisia, and their synonyms are much involved in confusion.

31. Siphonophora solidaginis, *Fabr.* Plate XXV.

Aphis solidaginis, Fabr., Hausmann, Kalt.
Siphonophora solidaginis, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·120×0·050	3·04×1·27.
Length of antennæ	0·150	3·81.
,, cornicles	0·045	1·13.

Large, long, almost linear. Head and thorax narrow. Garnet red. Eyes dark brown. Antennæ fine. First, second, sixth, and seventh joints black, the next ochreous. Cornicles long, cylindrical, and black. Tail very small, about a quarter the length of cornicles. Abdomen carinated. Every segment of the body spotted with black tubercles. Legs fine yellow, with black femoral and tibial points; tarsi black. The young are still more linear in form.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wing	0·320	8·12.
Size of body	0·110×0·040	2·79×1·01.
Length of antennæ	0·150	3·81.
,, cornicles	0·030	0·76.

Long and tapering to the tail. Head, pro- and meso-thorax, shining black. Antennæ long, and like those of the larva. Abdomen free from tubercles, pointed behind. Shining rich garnet-red. Margin

corrugated. Dorsum convex. Cornicles and legs as in the larva. Tail black, about half the length of the cornicles, very hairy. Wing-insertions, costa, and cubitus, pale yellow. Stigma greyish. Veins fine and of a pale brown.

This insect forms large clusters on the flower-stalks of the goldenrod, *Solidago virgaurea*. It has been confounded with *Siphonophora sonchi*.

32. SIPHONOPHORA MURALIS, *Buckton*. Plate XXVI.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·120×0·055	3·04×1·39.
Length of antennæ	0·160	4·06.
,, cornicles	0·050	1·27.

This larva has a considerable resemblance to *S. sonchi*, but the legs and antennæ are longer, the tubercles are less marked, and the yellow cauda equals half the length of the cornicles. The insect is hirsute, shining brown, and wrinkled. Eyes dark brown.

It is considerably larger than either the pupa or the imago.

Pupa.

Size 0·090×0·050. Pale reddish-brown with pale greenish-yellow thorax, wing-cases, antennæ, and legs. Both the latter are tipped with brown.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wing	0·340	8·63.
Size of body	0·085×0·030	2·14×0·76.
Length of antennæ	0·140	3·55.
,, cornicles	0·030	0·76.

Almost linear. Head and thorax dark brown. Antennæ long and black. Abdomen long oval,

garnet-red. Dorsum convex and ringed, without markings or tubercles. Cornicles long, thin, black, and usually carried at right angles to the body. Cauda yellow and long. Legs pure yellow, with dark femoral and tibial points, tarsi black. Wings large, somewhat fuscous. Insertions yellow. Cubitus, costa, and stigma, pale brown. Other veins stout and black.

The male.

	Inches.	Millimètres.
Expanse of wing	0·210	5·33.
Size of body	0·040 × 0·020	1·01 × 0·50.
Length of antennæ	0·080	2·02.
,, cornicles	0·012	0·30.

This sex is remarkably small. Colour uniformly umber-brown. Legs and cornicles ochreous. The femoral and tibial points darker brown. Antennæ long, and placed on projecting but not conspicuous tubercles. Wings very delicate, with grey stigmata and veins. Found indiscriminately mixed with the above viviparous females.

Oviparous apterous female.

In company with the above males some small cinnamon brown insects, with broad heads and short, stout, yellowish legs were observed. These probably were the true females, although no ova could be detected within. This absence of eggs might be due to the early time of year, viz. the first week in July. This species was feeding on the flower-stalks of *Lactuca muralis* at Weycombe, Haslemere. Koch states that his *Siphonophora lactucæ* is without tubercles or tufts of hair, and also states that it has a dark dorsal patch and spots surrounding the nectaries. Thus, notwithstanding the similarity of the food-plant I am compelled to consider this insect distinct. The trivial

specific name I have chosen implies very little, and in no ways indicates the only food selected by the Aphis.

33. SIPHONOPHORA TANACETICOLA, *Kalt.* Plate XXVII, figs. 1, 2.

Aphis tanaceticola, Kalt.
Siphonophora tanaceticola, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·075 × 0·040	1·89 × 1·01.
Length of antennæ	0·110	2·79.
,, cornicles	0·020	0·50.

Long oval, attenuated towards the thorax and head. Bright garnet-red, shining. Head broad, vertex tufted. Eyes brown. The older specimens much carinated and ringed. Covered with small black tubercles and hairs. Cornicles black and slightly curved. Cauda small and yellow. Legs reddish-yellow. Tarsi black. Antennæ long, yellow, and, like the legs, hairy.

Pupa.

Coloured much like the larva. Head brown and very broad. Wing-cases yellow like the legs.

Feeding on the tansy, *Tanacetum vulgare.* Taken in May at Abingdon by Mr. Frederick Walker, who kindly furnished me also with the larvæ. In confinement they developed into pupæ, but I failed to obtain the imago. This does not appear to be a common species.

4. SIPHONOPHORA TUSSILAGINIS, *Walk.* Plate XXVII, fig. 3.

Aphis lactucæ, Fabr.
,, *tussilaginis*, Walk.
Siphonophora lactucæ, Koch.
,, *tussilaginis*, Koch., Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·100×0·060	2·54×1·52.
Length of antennæ	0·170	4·31.
,, cornicles	0·035	0·88.

Large, globose, flat. Rich brown with a brassy lustre in certain lights. Abdomen much carinated. Dorsum convex. Without tubercles. Antennæ very long, hirsute, ochreous. Cornicles curved. Stoutest at the bases, black, except in the middle which is ochreous. Tail yellow. Legs large and coarse, particularly the fore legs. Femora dark brown; tibia ochreous, with black points and tarsi. Eyes brown. Crowded under the leaves of *Tusillago farfara* in July. Haslemere.

I have not met with the imago, although I have often seen the under side of the leaves covered with the apterous forms. Koch describes the imago as having head and thorax black. The side of the abdomen brown with shining dark round spots round the borders. Pupæ rust-brown.

35. SIPHONOPHORA SISYMBRII, *Buckton*. Plate XXVII, figs. 4, 5.

Apterous viviparous female.

	Inches.	Millimètres.
Size of the body	0·100×0·045	2·54×1·13.
Length of antennæ	0·120	3·04.
,, cornicles	0·040	1·01.

Rich ochreous-brown, very shining. Head, thorax, and abdomen divided from each other by a bright ochreous band. Lower part of the abdomen and lateral edges ochreous. Body covered by small black tufted tubercles. Tail long and yellow. Nectaries black. Legs wholly black, except the upper halves of the femora, which are bright yellow.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·340	8·63.
Size of body	0·100 × 0·050	2·54 × 1·27.
Length of antennæ	0·160	4·06.
„ cornicles	0·020	0·50.

Colour much as in the apterous female. Cornicles relatively shorter. Antennæ very long. The abdomen in the winged state is not tuberculate or tufted with hair. Wing-insertions pale green. Stigma greyish. Veins fine.

This insect has some resemblance to *S. sonchi*, the next species, but differs from it in having the tarsi all black, a smooth abdomen, and by the presence of three large obscure spots on the abdominal edges. The underside is all green, except a black anal patch and black coxæ.

Taken plentifully at Pembroke in August on the hedge mustard or rocket, *Sisymbrium officinale* by Mr. Chas. Barrett.

SIPHONOPHORA SONCHI, *Linn.* Plate XXVIII.

Aphis sonchi, Linn., Fab., Schr., Kalt., Walk.
„ *serratulæ*, Linn., Schr., Kalt.
„ *campanulæ*, Kalt.
S. sonchi, Pass.
Sonchifex, Amyott.
S. alliariæ, No. 1, Koch.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·120 × 0·060	3·04 × 1·52.
Length of antennæ	0·140	3·55.
„ cornicles	0·040	1·01.

Large. Body ovate, but narrow towards the head. Rich chestnut-brown. Shining. Antennæ long and

black. Front pointed, and tufted with hair. Eyes brown. Thorax and prothorax distinctly divided. Abdomen carinated, with transverse rows of setigerous tubercles. Last rings hirsute and narrowing to a point, which ends with a small yellow tail. Cornicles long, fine, and black. Legs thin, ochreous, with black femoral and tibial points.

Very plentiful throughout June, July, and August.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·320	8·12.
Size of body	0·100×0·050	2·54×1·27.
Length of antennæ	0·130	3·30.
,, cornicles	0·030	0·76.

Head and thorax shining black. Abdomen warm chestnut-brown, very shining. Four setigerous tubercles arranged on each lateral edge. Antennæ and legs as in the apterous female. Cornicles long, black, sometimes curved. Cauda yellow, and one third the length of the cornicles. Wings gauzy brown, iridescent, with yellow insertions. Cubitus and stigma pale brown. Veins very fine.

This species is almost omnivorous. Its common habitat is the great knapweed, *Centaurea nigra*, and *Sonchus oleraceus*. It may also be found on *Picris hieracioides*, *Hieracium sylvestre*, *Crepis biennis*, *Lapsana communis*, *Serratula arvensis*, *Carduus nutans*, and *Chrysanthemum segetum*.

Mr. Walker mentions thirty plants which form the food of *S. sonchi*. Its omnivorous character doubtless has been one cause of its numerous synonyms.

According to Mr. Walker the male is black, with a dark green abdomen and black cornicles. It appears in September.

Kaltenbach thinks, that notwithstanding certain discrepancies, *S. lactucæ* of Koch is identical with his *S. sonchi*, and Passerini comes to the same conclusion.

As Koch, however, describes his insect to be smooth, without knobs or hairs on the abdomen, and also notices a large dorsal spot, I conclude it is not the insect that I figure.

Aphis picridis of Kaltenbach also may be different, as the abdomen is stated to be shagreened, and the tail to be two thirds the length of the nectaries.

There are noticeable slight differences also in the insect which feeds on several kinds of hawkweed (Hieracium). The adult apterous females are like *S. sonchi*, but their young are green, with black nectaries. Again, the winged females are identical with *S. sonchi*, except that their abdomens are dark green instead of rich brown, and their nectaries are green at their bases. I believe these are varieties.

37. SIPHONOPHORA CICHORII, *Koch*. Plate XXIX, figs. 1, 2.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·075 × 0·030	1·89 × 0·76.
Length of antennæ	0·095	2·34.
„ cornicles	0·017	0·42.

Long oval. Wholly shining olive-green. Head and thorax broad. Antennæ dark green, with black at the joints. Abdomen long, carina deeply pitted. Dorsum convex and studded with dark tubercular spots. Slightly bristly. Cornicles long, thin, and green. Cauda green and hairy. Legs with femora darker than the tibiæ. Eyes red.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wing	0·280	7·10.
Size of body	0·090 × 0·035	2·27 × 0·88.
Length of antennæ	0·140	3·55.
„ cornicles	0·022	0·55.

Larger than the larva. Very smooth and shining. Entirely fine reddish fawn colour. Tail, femora, and wing-insertions fine yellow. Antennæ, tibiæ, tarsi, and cornicles black. Cubitus and stigma pale. Veins very delicate. The sides of the insect are covered slightly with a greyish bloom.

Feeding on the corn-cockle or campion, *Agrostemma githago*, in June, at Haslemere.

Although this Aphis does not entirely agree with Koch's description, I believe the two insects to be identical. Notwithstanding Kaltenbach's suggestion that *S. cichorii* is *A. serratulæ* of Linnæus, I must express doubts as to the fact.

36. SIPHONOPHORA OLIVATA, *Buckton.*

Aphis carduina, Walk. (?). Plate XXIX, figs. 3, 4.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·110 × 0·060	2·79 × 1·52.
Length of antenna	0·120	3·04.
,, cornicles	0·040	1·01.

Large, oval, yet attenuated before and behind. Head and thorax narrow. Eyes red. Whole insect olive brown, covered with minute black tubercles. Body not wrinkled. Cornicles long, straight, and black. Cauda one third the length of cornicle, black. First, second, and three last antennal joints olive. The rest luteous or ochreous. Legs similarly coloured with black knees, tibial joints, and tarsi.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·400 to 0·360	10·16 to 9·14.
Size of body	0·100 × 0·040	2·54 × 1·01.
Length of antennæ	0·180	4·56.
,, cornicles	0·040	1·01.

Very large. Head and thorax black. Abdomen olive-green or reddish-brown, with black lateral spots on the carina, and black tubercles. Slightly hirsute. Tail very long, ensiform, luteous or pale green. Antennæ very long, greenish. Legs much as in the larva. Cornicles long, thick at the base, and curved. Wings ample. Membranes slightly olive, very slightly iridescent. Insertions and stigmata pale greenish. Veins fine, brownish. Rostrum long, reaching to the third coxæ. The sternum and anal plate black.

Very numerous at Lynchmere, Sussex, crowding on the flower-stalks of the thistle, *Carduus lanceolatus*, during the middle of August.

I can find no description of this insect by former observers. Also I am unable certainly to say that it is *A. carduina* of Walker, which has green cornicles and a green flat body.

Genus II.—PHORODON,* *Passerini.*

Rostrum moderately long, reaching to the second coxæ.

Antennæ hardly longer than the body. First joint bluntly toothed or gibbous. Third joint the longest. Fourth and fifth joints nearly equal. Vertex flat. Frontal tubercles each with a strong characteristic tooth developed on their inner sides.

Cornicles long, cylindrical, and slightly clavate.

Cauda short. Legs also short.

Wings moderately long, with venation as in *Siphonophora.*

N.B.—The porrected frontal tubercle, taken by itself, is of no generic import, as it may be found in the males of some other genera. Its presence has its significance only when it accompanies the gibbous form of the first antennal joint.

* Φορέω, I bear, ὀδοὺς, a tooth.

The toothed frontal tubercle is most developed in the apterous viviparous females.

PHORODON HUMULI, *Schrank*. Plate XXX.

Aphis humuli, Schrank., Kalt., Walk., Koch.
„ *pruni*, Scop.
„ *humulifex*, Amyott.
Phorodon humuli, Passerini.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·055 × 0·025	1·39 × 0·62.
Length of antennæ	0·040	1·01.
„ cornicles	0·015	0·38.

Small, oval, pale green. Eyes red. Frontal tubercles dentate. First joint of the antennæ gibbous and porrected. Body sometimes shining, and sufficiently transparent to allow the tracheæ to appear like silver threads, which form a kind of segmentation on the dorsum. From one to three green stripes pass down the back. Cornicles straight and cylindrical. Tail and legs rather short.

Pupa.

Head, prothorax, and thorax broad and squarish. Two red spots on the vertex mark the seats of the future ocelli. Abdomen pointed at the apex. Whole insect green and slightly pilose.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·260	6·60.
Size of body	0·070 × 0·025	1·77 × 0·62.
Length of antennæ	0·080	2·02.
„ cornicles	0·017	0·40.

Pale green. Lighter underneath. Antennæ about equal to the body, green at their bases, tips brown. Head and band on prothorax dark brown. Thoracic lobes, one or more cross stripes on the abdomen, and four spots on each edge, black. Anal plate black. Cornicles green. Legs with brown femoral and tibial joints. Tail pale. Wings ample, cubitus and stigma greenish yellow. Other veins pale brown. The peculiar characters of the frontal tubercles are less marked in the winged females.

Winged male.

	Inches.	Millimètres.
Expanse of wings	0·200	5·08.
Size of body	0·045 × 0·020	1·13 × 0·50.
Length of antennæ	0·070	1·77.
,, cornicles	0·010	0·25.

Less bulky in form than the winged female. Antennæ and wings very long. Head and thorax much developed. Abdomen attenuated. Colour wholly pale green excepting the thoracic lobes and scutellum, which are olive. The frontal tubercles are prominent and thrown forward. Wing-veins as in the winged female.

Taken in the middle of October on the hop plant.

Walker says that *P. humuli* migrates in early spring from the sloe, *Prunus spinosa*, to the hop plant, and again leaves the hop in autumn to go back to the sloe; indeed, he says this migration may occur more than once in one season. He believes that the two Aphides infesting these dissimilar plants are really identical. Passerini in commenting on this subject says, it is hard to comprehend that such a cause, viz. an alteration of food, can produce an organic change of such consequence as the absence of the tooth on the frontal tubercle. He argues that the existence of the genus *Phorodon* depends chiefly on this characteristic, and as his (*Italian*) specimens from *Prunus spinosa* all

want this tooth, they cannot belong even to the same genus as *P. humuli*.

There is some difficulty in deciding on this point of identity. Koch says that his *Aphis malaheb* is closely related to *A. humuli*, but that it wants the projecting branch on the first root-joint (ersten Wurzelglied) which distinguishes that species,* by which I understand him to mean that the first antennal joint is not toothed. On the other hand, Passerini,† from reasons above given, excludes *Malaheb* from *Phorodon*, and places it in his genus *Myzus*.

Once more, Kaltenbach considers *Aphis malaheb* of Koch to be a variety of *A. pruni* of Boyer de Fonscolombe. Thus Koch and Passerini decide differently from Kaltenbach and Walker.

I incline to the opinion of the latter authors, and therefore I figure it as a variety only. The difference, which, however, is not small, appears chiefly in the younger individuals of the apterous females.

For comparison I have figured these parts of the head and antennæ in their various stages of development, and here I add a description of *P. malaheb*, which I regard as a variety.

2. PHORODON HUMULI var. MALAHEB, *Fonsc.* Plate XXXI, figs. 1—4.

Aphis pruni, Fonscolombe.
,, *malaheb*, Koch.
Myzus malaheb, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·110×0·052	2·79×1·30.
Length of antennæ	0·070	1·77.
,, cornicles	0·030	0·76.

* 'Die Pflanzenläuse Aphiden,' von C. L. Koch, p. 113.

† Vide "Fiora degli Afidi Italiani finóra osservati," 'Il Bullettino Entomologico,' Anno III, also 'Zoologist' for March, 1862, p. 1122.

Rather larger than *P. humuli;* abdomen also broader. Figure long oval. Head and thorax taken together equal only to one fifth of the length of the body. Colour yellowish-green, with three darker green stripes on the back. Head narrow. Frontal tubercles porrected, but less so than in *P. humuli.* First antennal joint gibbous. Eyes red. Legs and antennæ green.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·280	7·10.
Size of body	0·075×0·025	1·89×0·62.
Length of antennæ	0·070	1·77.
„ cornicles	0·015	0·38.

Bright green, shining. Head, lobes of the thorax, antennæ and legs, with the exception of the upper parts of the femora, black. Abdomen with several interrupted dark transverse bands, and three large spots on the carina. Two black spots under the insertions of the wings. First antennal joint gibbous.

Common in May and June in the sloe, and also in the garden plum, under the leaves of which it forms considerable companies, though not so large perhaps as those of *Aphis pruni.*

The ravages done by *Phorodon humuli* in some seasons to the hop gardens of England are very great. The writer of the article "Aphis" in the 'Penny Cyclopedia' stated, that as long ago as the year 1802 the excise duty paid on hops of the previous year fell from £100,000 to £14,000, and that the deterioration in value was entirely ascribed to the ravages of "the fly." Another writer in 1833 stated that the duty paid for hops when the fly was absent amounted to half a million of money.

The agriculturist with anxiety therefore regards the movements of this pest, and long has called for some efficient method for checking its wonderful multipli-

cation. It is believed, however, that hitherto all plans and schemes practically have failed, and that the farmer will find henceforth his best policy to consist in a study of the economy of the Aphis under notice, and in a furtherance, as far as may be in his power, of the increase of some of the natural foes which prey upon it.

Chief amongst these enemies and checks to such superabundant life may be mentioned the numerous species of *Coccinella*, which forms one group of the large family of Coleoptera. It would appear that the beneficial influence to man exerted by these insects has been long and widely recognised.

The singular popular names given to them throughout Europe seem to have reference to the inflence of a supreme Power, which through them staves off famine and preserves vegetation.

Thus, in Lombardy the popular synonym of our English Ladybird is, "Bestioline del Signore." In Tuscany it is "Madonnine" or "Marioline;" in France it is "Bête" or "Vache à Dieu." In Germany the name is less suggestive, "Sonnenkäfer."

The food of Coccinella consists almost exclusively of Aphides. Their marvellous voracity is shown equally in their larval and their winged condition. The former stage may be commonly seen throughout early summer as slaty-grey or brown six-footed creatures, covered with tufted tubercles, and provided with mandibles efficient both for holding and sucking out the juices of their victims.

In some years the imagos are wonderfully numerous, and when they take wing, form vast swarms which travel great distances. By their sudden appearance in a district they often raise popular astonishment. In the year 1869 such a cloud passed over a large part of Kent, Sussex, and Surrey; alighting on the footways of Maidstone, Guildford, and Midhurst, and making it difficult to avoid crushing hundreds under foot.*

* The good hop crop of the following year, perhaps, was the consequence of this prevalence of Coccinella.

In the autumn the perfect insect often enters houses for hybernation, and clusters of many hundreds may be seen in crannies and under the ceilings, and in the angles of the walls of houses within the hop districts. These clusters sometimes are so large, that a half-pint measure would not contain them.

Although the Coccinella is not restricted to the hop Aphis for its food, it frequently follows its migrations, and travels on the same winds. It is also a valuable visitor to the apple orchard, and destroys thousands of *Aphis mali* and *A. pruni*. Whilst feeding, the Aphis is seized by the "Ladybird" near the back, and the liquid contents are quietly sucked out of the abdomen, about one minute being required for this process. The Aphis is held and manipulated by the jaws and palpi of the Coccinella, and the devouring operation proceeds, amidst the struggles of the victims, from the tail to the thorax, which parts, together with the head and legs, are finally rejected.

We may express some hope, in sympathy with the Aphis, that the automatic theory of animal life may here find some place, and that reflex action may explain the fact, that under the microscope the mutilated parts, without stomach and without internal organs, have been seen to walk away and live after the operation for a considerable time!

Automatically, the Coccinella furbishes up its jaws, and antennæ, in readiness for another meal. From thirty to forty Aphides thus may be consumed in one hour.

The imago of *Coccinella septem punctata* is too well known to permit any remarks upon it here. I have figured the less known pupa and larva.

3. Phorodon galeopsidis, *Kalt.* Plate XXXII.

Aphis galeopsidis, Kalt., Walker.
Phorodon galeopsidis, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·055 × 0·025	1·39 × 0·62.
Length of antennæ	0·055	1·39.
,, cornicles	0·010	0·25.

Oblong, dull greenish-white. Slightly punctured. Eyes bright red. Antennæ fixed on tubercles, which are but slightly toothed. First joint large and gibbous. Front garnished with capitate hairs. Cornicles long, cylindrical. Legs short, hirsute. Rostrum moderately long. Tail obtuse, fringed with capitate hair. The eyes of the embryos often appear as red spots on the skin.

Pupa.

Yellow tinged with red. Legs short. Cornicles slightly clavate.

Late in the month of August I captured, in company with the viviparous females, a number of small pupæ having large heads, prominent red eyes, and abdomens thickly barred with dark green. The legs and wing-cases were nearly white.

Although I could not succeed in breeding the winged forms from these diminutive pupæ I regard them as belonging to the males. I did not detect the oviparous female in company.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wing	0·240	6·09.
Size of body	0·090 × 0·035	2·27 × 0·88.
Length of antennæ	0·080	2·02.
,, cornicles	0·017	0·43.

Head, prothoracic band, and thoracic lobes, dark olive brown. Frontal tubercles small. First antennal joint gibbous. Scutellum and a broad squarish patch on the dorsum dark brown. Abdomen oval, green,

with transverse rows of black spots. Cornicles green, clavate, and curved. Tail about half the length of nectaries, pale green. Rostrum short, reaching to the first coxæ only. Legs short, with dark femora and tibia points. Wings rather short. Insertions yellow. Cubitus brown. Stigma grey.

This insect may be found on various plants, and in some seasons is not uncommon. It feeds under the leaves of *Galeopsidis tetrahit*, *Lamium album*, and *Stachys sylvatica*. The specimens figured are from *Polygonum persicaria*, and were taken in September.

Genus III.—MYZUS,* *Passerini.*

Rostrum much like Phorodon.

Antennæ about equal to the length of the body. Frontal tubercles strongly porrected in the males, but less so in the other sexes. The first joint gibbous, not dentate.

Cornicles cylindrical, rather long.

Tail about one third the length of the nectaries.

Legs stout and moderately long.

Wing-venation as in Phorodon.

The chief difference of this from the preceding genus is the absence of the tooth on the first antennal joint. Except from the very remarkable development of the frontal tubercles in the viviparous females of *P. humuli*, the two genera might be united.

Passerini takes *Myzus cerasi* for the type of his genus. In England *Myzus ribis* appears to be a more characteristic insect.

* Apparently from Μύζω, sugo.

MYZUS CERASI, *Fab.* Plate XXXIII.

Aphis Cerasi, Fab., Schr., Fonsc., Kalt., Walk., Koch, Fitch.
Cerasaphis, Amyott.
Myzus cerasi, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·075 × 0·045	1·89 × 1·13.
Length of antennæ	0·060	1·54.
,, cornicles	0·020	0·50.

Oblong-globose. Black, shining, rugose. Abdomen very broad. Antennæ rather shorter than the body. First joint yellowish, other joints black. Abdomen very shining, minutely shagreened. Cornicles long, cylindrical. Cauda long and black. Legs ochreous, very stout, and hirsute. Femora, tibial tips, and tarsi black. Eyes dark brown.

Pupa.

Smaller than the larva, more oblong ; shining olive-green. Cauda obtuse. Wing-cases resinous yellow.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·260	6·62.
Size of body	0·065 × 0·035	1·64.
Length of antennæ	0·070	1·77.
,, cornicles	0·015	0·38.

Body wholly black, shining. Abdomen globose, broad across the dorsum. Antennæ rather longer than body. Legs as in the larva. Cornicles straight, cylindrical, and black. Cauda one third the length of the cornicles. Wings ample and broad. Cubitus and

insertions yellow, stigma greyish. Sometimes the abdomen is clouded with yellowish green.

The Male.

	Inches.	Millimètres.
Expanse of wings	0·250	6·35
Size of body	0·060×0·035	1·54×0·88.
Length of antennæ	0·090	2·27.
„ cornicles	0·017	0·42.

Head, band on prothorax, thorax, and antennæ brownish black. Abdomen small, elongated towards the apex. Ochreous yellow, with five brown transverse bars, and four marginal spots on each side. Cornicles long and ochreous yellow. Cauda yellow. Legs ochreous brown, with femora and tibial joints dark brown. Antennæ very long. Frontal tubercles porrected.

Wings very long, stigma and cubitus greyish.

Oviparous female.

Much smaller than the viviparous female. Proportions very different from the other forms.

	Inches.	Millimètres.
Size of body	0·057×0·033	1·44×0·83.
Length of antennæ	0·037	0·92.
„ cornicles	0·007	0·17.

Dark shining brown or ochreous brown. Globose. Antennæ about half the length of the body. Frontal tubercles well marked. Two deep depressions between the eyes. Cornicles very short. Cauda hairy. Two large eggs were obtained by dissection. Found in company with several males under the leaves of the garden cherry, *Cerasus vulgaris*. Also taken by Mr. Walker at Wanstead, October 31st.

I unexpectedly obtained viviparous specimens from the black currant about the same time, which were quite identical in form with those from the cherry.

The sole difference was that the bodies were duller, and the cornicles were paler. The pupa figured is from the black currant.

This Aphis does much injury to the cherry orchards in early spring, when they cluster by thousands under the leaves and dry them up as if scorched by heat. Fitch in America counted 190 individuals ranged down the midrib of one leaf. They often choke and gum up the pores of the leaves by the secretion which they eject from their cornicles. On account of this sweet substance the affected branches are much visited by ants.

Two swarms usually occur in the year with a certain interval, one in June and the other in October. During the latter period the male makes its appearance. Mr. Walker states that in Essex it was frequent in October, 1866. He describes them as wholly black, and probably the older specimens often are so coloured.

Fitch describes an Aphis, common in America on the cherry, under the name *Aphis cerasifoliæ*. Possibly it may prove to be a variety of the European species, but as he says the body is green, and gives some other small differences, it is not safe to include it amongst the synonyms of the insect here described.

2. MYZUS GRACILIS, *Buckton*. Plate XXXIV, fig. 5.

The apterous viviparous female is as yet unknown.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·280	7 ~~8~~·10.
Size of body	0·100 × 0·040	2·54 × 1·01.
Length of antennæ	0·090	2·27.
" cornicles	0·020	0·50.

Pale green. Head and thorax together as long or longer than the abdomen. Head small and brown.

Antennæ rather short. Frontal tubercles obvious. Ocelli distinctly marked. Prothorax large, with a brown rhomboidal-shaped band. Mesothorax much developed. Three thoracic lobes small, and pointed anteriorly. Scutellum brown. Abdomen oval, with a few faint cross streaks of brown. Cornicles cylindrical and very thin. Tail fine. Legs moderate; tibial joints and tarsi brown. Wings ample. Cubitus and insertions green. Stigma grey, veins dark brown. Found on the sycamore in company with *Chaitophorus aceris* early in November at Shottermill, near Liphook. At that time I could find no larvæ, and possibly the sycamore is not its usual food.

Winged male.

	Inches.	Millimètres.
Expanse of wings	0·320	8·12.
Size of body	0·090 × 0·030	2·27 × 0·76.
Length of antennæ	0·090	2·27.
,, cornicles	0·015	0·38.

Bright ochreous yellow. Thoracic region largely developed. Abdomen small. Head, band on prothorax, thorax, and pectus rich brown. Also a patch below the wing-insertions rich brown. Abdomen with brown transverse bands, and five or six dots on each carina. Tail small. Genito-anal valves large. Antennæ black. Wings as in the winged female.

Several of these males were found in November mixed with the preceding females, herding also with individuals of *Chaitophorus aceris*. I could not discover the oviparous female; but as in other species she usually makes her appearance a little after the disclosure of the male, probably at this advanced season she was hiding in the crevices of the bark, and at no great distance.

3. Myzus persicæ, *Sulzer*. Plate XXXV.

Aphis persicæ, Sulz.
— *insititia*, Koch.
— *persicæcola*, Boisduval.
— *persicophila*, Rondani.
Myzus persicæ, Passerini.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·060 × 0·030	1·54 × 0·76.
Length of antennæ	0·040	1·01.
„ cornicles	0·010	0·25.

Ovate, rosy or rusty red. Head broad, with frontal tubercles much porrected. Two dimples behind the eyes. Antennæ, legs, and cornicles greenish. Thorax and abdomen deeply furrowed. The segmentation strongly marked on the under side. Five or more depressions or pore marks on each lateral edge. Cauda inconspicuous. Cornicles yellowish, long, and cylindrical. Rostrum reaches to the third coxæ.

Pupa.

	Inches.
Size	0·080 × 0·035.

Colour much like that of the larva, but three greenish stripes usually are seen down the dorsum. Wing-cases yellow, tinged with green. Two red spots on the occiput.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·320	8·12.
Size of body	0·075 × 0·035	1·89 × 0·88.
Length of antennæ	0·085	2·15
„ cornicles	0·012	0·30

This insect is very variable as to colour, some to the naked eye appearing quite black, whilst others are brown or olive brown and black.

Var. *a*.—Head, thorax, cornicles, antennæ, femora, and tibial joints dark brown or shining black. Abdomen green, with one, two, or three transverse dark marks, and a large squarish dark patch between the cornicles. Four deep black punctures on each lateral edge. Cornicles fine and cylindrical. Cauda black and pointed. The third joint of the antennæ tuberculated. Legs greenish. Wings large. Insertions pale. Stigma grey. Rostrum reaches nearly to the third coxæ.

Var. *β*.—More or less orange or red, with brown thoracic lobes and brown sternum, which last is deeply channeled.

Winged male.

	Inches.	Millimètres.
Expanse of wings	0·270	6·85.
Size of body	0·085×0·035	2·14×0·88.
Length of antennæ	0·090	2·27.
" cornicles	0·010	0·25.

Bright citron yellow. Head, band on the prothorax, thoracic lobes, and many transverse dorsal streaks, fine brown. Frontal tubercles porrected. Third antennal joint tuberculate. Eyes fine red. Cornicles thin, slightly clavate and black. Tail small and black. Legs yellow, with brown tarsi and tibial joints. Wings moderately long. Veining as in the winged female.

Taken on the nectarine, *Amygdalus*, October 29th, at Haslemere.

By dissection under weak syrup, the male organs were very satisfactorily brought into view, the convoluted testes and the singularly sickle-formed penis being well shown.

Koch says that the male occurs in the early part of

May, a most unusual time of year for the occurrence of any male of the family Aphididæ.

There can be but little doubt, that *Aphis insititia* of Koch, feeding on the wild plum, is identical with this species.

Myzus persicæ is common on both the peach and the nectarine. The winged form may appear as early as the first week of May. In June I saw Aphides taken from the apple tree, which in form and colour could not be separated from *M. persicæ.* In October, 1870, these insects appeared in immense numbers on the peach trees at Clifton, near Bristol, and they much alarmed the neighbouring non-naturalists as to the safety of the trees. Schneidberger says this Aphis has sixteen generations before the occurrence of the oviparous female. We cannot doubt, however, that climatal and such like causes must make the above periods of birth very uncertain.

The beautiful colour of this Aphis is mainly caused by a quantity of highly refractive globules of pink oil, which mass themselves in various parts of the body, and particularly so at the roots of the cornicles. These last organs are often fully charged with them.

4. MYZUS RIBIS, *Linn.* Plate XXXIV, figs. 1—4.

Aphis ribis, Linn., Fabr., Schr., Kalt., Walk.
Ribifex, Amyot.
Rhopalosiphum ribis, Koch.
Myzus ribis, Pass.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·085×0·040	2·14×1·01.
Length of antennæ	0·090	2·27.
,, cornicles	0·015	0·37.

Long oval. Shining yellow or green, with darker green mottlings. Front flat, garnished with short

bristles, as also are the sides. Antennæ long and very fine. Cornicles cylindrical, pale green. Eyes bright red. Cauda obtuse. Legs yellow or greenish.

Under a high magnifying power these bristles are capitate, a fact not in accordance with the experience of Passerini, as regards the Italian species.

Pupa.

Large, shining yellow, or green. Two brown spots on the occiput. Abdomen convex and glistering.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·300	7·62.
Size of body	0·100×0·045	2·54×1·13.
Length of antennæ	0·090	2·27.
,, cornicles	0·020	0·50.

Bright greenish-yellow. Head pale olive. Eyes red. Three ocelli obvious. Antennæ fixed on small tubercles. Prothorax with an indented olive band. Thoracic lobes brown. A stellate spot is seen on the post-thorax, succeeded by six or seven irregular transverse bands on the abdomen of varying thickness; four or five spots on each lateral edge. Cornicles green or olive, cylindrical, or at least very slightly clavate. Legs green, with olive femoral points and tarsi. Wings broad, with yellow insertions, greenish cubitus and veins. Stigma grey.

Plentiful from May to July on the red-currant bush, *Ribes rubrum*, and also on the gooseberry, *Ribes grossularia*. The continual punctures from the rostra cause large red or brown blisters on the leaves of the former plant, within which the Aphides swarm. The larva is very transparent, and is well suited for examination of the internal anatomy.

Although no dorsal vessel has yet been certainly made out which has the function of a heart in these minute insects, a continual rhythmical action of the internal

organs may be noticed in this species, which action probably is connected with some kind of circulation. The numerous oil-globules, however, are stationary and not propelled by any pulsating current.

Myzus ribis, no doubt, is *Rhopalosiphum ribis* of Koch. The last author, indeed, figures the larva with cylindrical nectaries, which do not agree with the dilated characters of *Rhopalosiphum*. Passerini's and my own specimens have cylindrical cornicles. Mr. Walker bears me out also by inserting *R. ribis* into his synonyms.

Passerini notices seven other species of *Myzus*, but none of them have come under my notice as British. His *Myzus tetrarhoda* is probably *Siphonophora rosarum* of Koch.

Genus IV.—DREPANOSIPHUM,* *Koch.*

Säbel-Laus, Sickle-Aphis.

Rostrum short. Penultimate joint long.

Antennæ long and fixed on the frontal tubercles. Third joint the longest. Fourth and fifth joints equal. Seventh setaceous.

Cornicles large, curved, and dilated in the middle.

Legs moderately long.

Cauda inconspicuous or none.

Wings long and narrow. Cubital vein twice forked. Stigmatic cell elongated towards the apex of the wing. Other veins parallel to each other or nearly so. The membrane slightly clouded towards the marginal ends of the veins.

It has been stated by Walker and others, that there are no apterous viviparous females in this genus, by which only can be meant, that all the apterous females develop into pupæ and thence into winged forms

* From Δρέπανον a sickle, and σίφων a tube.

before they produce young. The imagos appear very early in the spring, very soon after the unfolding of the leaves. Later in autumn the perfect sexes come on the scene, and then they may occasionally be found *in coitú.*

The habits of this genus are sporadic. Large companies are not formed, but the insects nestle under the leaves in numbers rarely exceeding five.

DREPANOSIPHUM PLATANOIDES, *Schr.* Plate XXXVI.

Aphis platanoides, Schr., Ratz., Kalt., Walk.
Drepanosiphum platanoides, Koch.
Siphonophora platanoides, Pass.

Apterous viviparous female (?).

	Inches.	Millimètres.
Size of body	0·080×0·030	2·02×0·76.
Length of antennæ	0·090	2·27.
,, ,, cornicles	0·020	0·58.

Oblong, almost linear. Bright green. Head and thoracic portion well developed. The rest of the abdomen much ringed. Two dark green stripes on the neck, followed by a long oval ring of green down the abdomen. Antennal joints strongly tipped with black. Insect covered with fine capitate hairs. Taken on the sycamore, *Acer pseudoplatanus*, as early as May the 5th. Very probably these develop into the pupæ.

Pupa.

	Variety 1.		Variety 2.	
	Inches.			Millimètres.
Size of body from	0·085×0·040	to	0·120×0·050.	3·04×1·27.
Length of antennæ	0·140		0·110.	2·79.
,, cornicles	0·030		0·025.	0·62.

Var. 1.—Wholly bright yellow, except two greenish stains down the dorsum. Head very broad. Antennæ

very long, the joints tipped with black. Hairs capitate.

Var. 2. — Much larger. Wholly emerald green. Oblong, flat. Wing-cases whitish. Abdominal wings well defined. Antennæ relatively much shorter than in Variety 1. Rostrum short.

Winged viviparous female.

	Variety 1.	Variety 2.	
	Inches.		Millimètres.
Expanse of wings	0·250	0·400.	10·16·
Size of body from	0·080 × 0·030 to	0·130 × 0·45.	3·30 × 1·13.
Length of antennæ	0·110	0·140.	3·55.
,, cornicles	0·035	0·020.	0·50.

Var. 1.—Bright green. Both head and prothorax marked with two pointed streaks. Ocelli large. Frontal tubercles conspicuous. Antennæ black. Thoracic lobes, spot below the scutellum, and six transverse abdominal bars, black. Also the two spots from which the green cornicles rise are black. Tail small. Legs brownish. Tarsi and tips of cornicles black. The setaceous seventh joint of the antennæ appears to be very liable to injury, even when the insect is at large. Thus, the antenna often appears to have less than its normal length.

Var. 2.—Considerably larger than the previous insect. Antennæ and legs less developed. Colouring much as on the former insect, but paler. Wings longer, with yellow insertions and cubitus. Veins brown.

The rostrum is very short, and does not reach to the second coxæ.

This species is much harassed and preyed upon by parasites. Often by an examination with the microscope, large, living, wormlike larvæ may be detected in, perhaps, nine out of every ten specimens examined.

D. platanoides is common in England and wherever the sycamore and maple flourish. The pupæ nestle by twos and threes under the leaves, and the winged females appear in the first week of May.

Kaltenbach likewise remarks that all the larvæ of the second and following generations from May to October assume wings, and that the Aphis appears of three different tints, viz. yellow, green, or brown, according to the time of year.

Apterous oviparous female.

Long oval. Green, transparent. Antennæ ringed with black. Eyes bright red. Vertex, thorax, a series of transverse bars on the dorsum, and certain irregular blotches on the sides, velvety brown or black. This sex differs much from the viviparous female in both colour and form.

It is not uncommon on the under side of the leaves of the sycamore just before they fall.

The last three abdominal rings are remarkably drawn out and expanded into a kind of sac, into which the ova pass before deposition. Fertilization takes place within this sac, and the change becomes visible by the alteration of the egg from its original green colour to a fine brown, the last tint commencing at the posterior end of the egg.

On account of its size and transparence, this species is well fitted for anatomical examination. Accordingly it was much employed by Balbiani in his investigations on the reproductive economy of Aphides.

DREPANOSIPHUM ACERINA, *Walk.* Plate XXXVII, figs. 1—3.

Aphis acerina, Walk.
Drepanosiphum aceris, Koch.

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·070 × 0·040	1·77 × 1·01.
Length of antennæ	0·100	2·54.
„ cornicles	0·015	0·12.

Bright orange, with redder sides. Body deeply segmented and carinated. Head very broad. Eyes red. Front convex. Antennæ long, and the joints tipped with rich brown. Legs stout and short; femoral tips and tarsi brown. Body hirsute. The dorsum is very transparent, and shows the oil-globules within the abdomen. These often are disposed in regular rows. Rostrum short. The young specimens are lemon yellow, with antennæ twice the length of their bodies, and with cornicles disproportionally large.

Captured at Walthamstow in November.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·300	7·62.
Size of body	0·080 × 0·025	2·02 × 0·62.
Length of antennæ	0·190	4·77.
" cornicles	0·025	0·62.

Somewhat linear. Head and thorax nearly as wide as the abdomen. Bright yellow. Eyes large and red. Antennæ very long, more than twice the length of the body. The joints tipped with brown. Two thoracic lobes and the scutellum rich sienna-brown. Two broad crossbars on the abdomen brown. Cornicles very stout. Legs yellow. Wings ample. Cubitus, stigma, and veins either green or pale brown. Tail inconspicuous. Rostrum short, not reaching to the second coxæ. The whole insect is hirsute.

This pretty insect is by no means common. It was first taken by Mr. Walker in October, 1847, and by him described. It feeds on *Acer pseudoplatanus*, and, like the rest of the genus, is very active and difficult to secure. The winged specimen figured was sent to me by Mr. Walker, and taken late in August near Walthamstow.

Genus V.—AMPHOROPHORA,* *Buckton.*

Rostrum longer than in Drepanosiphum.
Antennæ very long, and fixed on frontal tubercles.
Cornicles large and vasiform.
Legs stout and long.
Cauda rather large than otherwise.
In other respects like *Drepanosiphum.*

Amphorophora ampullata, *Buckton.* Plate XXXVII, fig. 4.

Rhopalosiphum staphyleæ, Koch. ?

Apterous viviparous female.

	Inches.	Millimètres.
Size of body	0·130 × 0·060	3·30 × 1·54.
Length of antennæ	0·220	5·58.
" cornicles	0·040	1·01.

Very large. Wholly green. Transparent, showing the embryos within, and thus giving a mottled appearance to the insect. Eyes bright red. Frontal tubercles large and somewhat gibbous. The first antennæ joint thick and long. The other joints taper, and black at their articulations. Cornicles black at their tips, well developed and vasiform, that is, thin at their origin, dilated in their middle, and expanded at their mouths, like a trumpet. Tail very large and yellow. Rostrum reaches rather beyond the second coxæ. Whole body slightly pilose. The under side is wholly green, but rather browner than the upper side. Tibial points brown, tarsi black, other parts of the legs green.

In many respects this Aphis answers to Koch's description of his *Rhopalosiphum staphyleæ,* which affects the bladder-nut of our shrubberies, *Staphylea pinnata.* Still, as the tail is not small, nor the nectaries tipped

* From 'Αμφορεὺς a pitcher.

with reddish, nor the eyes brown, I think it is certainly distinct. Whilst the great length of the antennæ would remove my insect from the genus *Rhopalosiphum*, the presence of a large tail would separate it from *Drepanosiphum.*

Again, if it be an invariable fact that *Drepanosiphum* has no apterous viviparous form, the presence of forward embryo in my specimens will be a sufficient justification for separating them from that genus.

These specimens were obligingly sent to me by Miss Henry from the conservatory of Blackdown House, near Lurgershall, Sussex. They were very numerous on the fronds of *Cystopteris montana.*

I believe this is the first notice of Aphides taking nourishment from the Fern family. Unfortunately I could breed no winged forms.

Genus VI.—MEGOURA,* *Buckton.*

Head broad. Front flat. Rostrum rather short. Antennæ much longer than the body. Frontal tubercles large; remote at their bases. Third joint the longest. Second joint twice the size of the first. Fourth joint longer than the fifth. Seventh joint setaceous. Abdomen globose, convex. Cornicles long, dilated in the middle, expanded at the ends or trumpet-mouthed. Cauda markedly long and thick.

Wings and legs as in *Siphonophora.*

Megoura viciæ, *Buckton.* Plate XXXVIII.

Apterous viviparous female.

		Inches.	Millimètres.
Size of body		0·110×0·070	2·79×1·77.
Length of antennæ		0·170	4·31.
,,	cornicles	0·025	0·62.
,,	cauda	0·030	0·76.

* From Μέγας great, οὐρὰ a tail.

Very large, globose, much domed; smooth, shining, green. Head, prothorax, and thorax nearly of the same breadth, distinctly separated by sutures. Head brown. Frontal tubercles very large and not gibbous. First antennal joint about twice the length of the second. The third the longest. The fourth and fifth decreasing in size. The sixth small, the seventh long and setaceous. Eyes large and red. The abdomen globular, so as to give the insect somewhat the form of a flask. The cornicles vasiform and dilated at the mouth. The anterior part thin. Colour black. Tail dark olive, hirsute, remarkably long and stout, tapering to the tip. Legs large, ochreous, and tipped as to the femora, tibiæ, and tarsi, with black. All the limbs are more or less hairy. Underside green, with two or three dark undefined blotches.

The young are green, with very pale legs.

Winged viviparous female.

	Inches.	Millimètres.
Expanse of wings	0·400	10·16.
Size of body	0·120×0·070	3·04×1·77.
Length of antennæ	0·160	4·06.
,, cornicles	0·017	0·43.
,, cauda	0·020	0·50.

Very large. Both head and prothorax narrower than the thorax, shining black. Abdomen as broad as it is long, bright green, with four large black lateral dots, the third of which surrounds the base of the nectary. A semicircular streak encircles the tail. Anal ring black. Antennæ as in the apterous female. Eyes prominent and vermilion-red. Cornicles vasiform and black. Cauda as in the apterous insect, furnished with ferruginous hair. Legs long and stout, ochreous, except the femoral and tibial tips, which are black. Wings moderately large, with green insertions, cubitus, and stigma. Other veins fine and greenish. Rostrum reaches to the second coxæ. The underside

is all green except the thorax, head, and a black anal patch. The figure of this Aphis is unusual and somewhat clumsy. It has the habit of dropping from the leaves at the approach of danger, and thus it is not easy to secure.

Specimens were sent to me from Keteringham, some few miles distant from Norwich. Mr. Barrett found them during two successive Septembers feeding on the green-seed pods of the vetch, *Vicia sepium*.

This insect has not been before described. It certainly is neither *Siphonophora viciæ*, Koch, nor *Aphis viciæ* of Kaltenbach. It has the mixed characters of *Siphonophora* and *Rhopalosiphum*, and this justifies, perhaps, the construction of a new genus, notwithstanding that at present it is the only known species comprised in that genus.

INDEX TO VOL. I.

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PLATE I.

Siphonophora rosæ. (Page 103.)

Fig. 1.—Eggs of *S. rosæ* deposited on a leaf bud of a briar, December 8th, 1872.

Fig. 2.—The young Aphis hatched from one of these eggs on March 12th, 1873, whilst the snow was on the ground and the thermometer marked 25° Fahr. In this stage the young Aphis is oblong; in colour ochreous-green, with an olive head, legs, and cornicles. Only thirteen segments can be easily counted, all of which are traversed by a pale dorsal stripe. The body is powdered with white meal. The small figure is of the natural size.

Fig. 3.—A young Aphis, seven hours old, born August 1st. Eight individuals were produced, all tail foremost, between the hours of ten and four. They still show little or no division between the thorax and the abdomen. Even at this early stage rudiments of embryos may be detected within the bodies. Immediately after birth the young began to absorb sap, and in a few hours afterwards they moulted their skins.

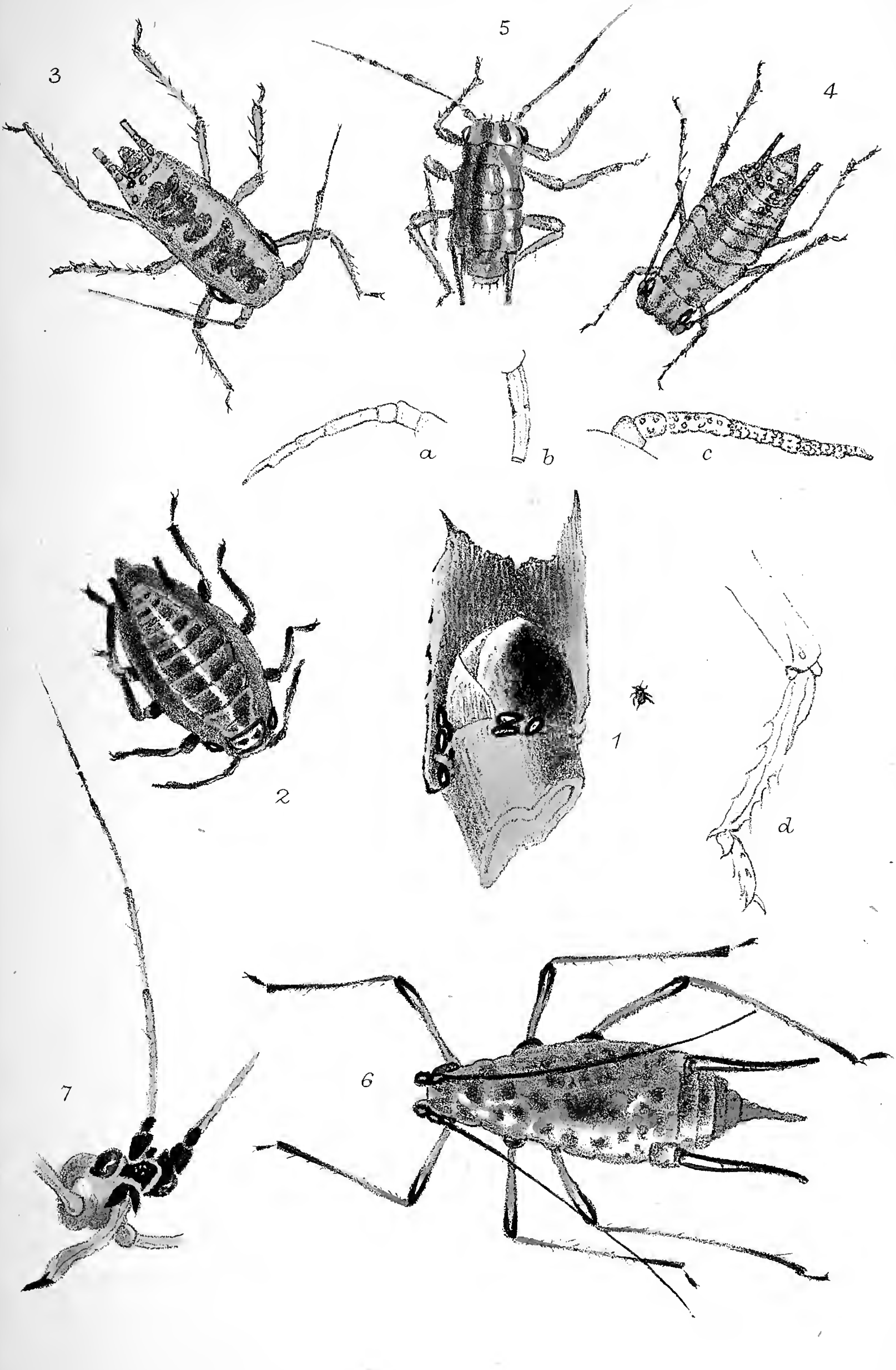
Fig. 4.—A young Aphis born in October; *c*, antennæ of the same. Only five joints can be distinctly traced; *d*, hind leg of the same. A second tarsal joint may be seen in a rudimentary form. The rostrum is very short and stout. It is greatly magnified in Plate III, fig. 7, and there are shown the setæ with their ramifications into the head.

Fig. 5.—Young born from a winged viviparous female, December 29th, 1873. The temperature of the preceding night was 24° Fahr. The antennæ joints have increased from five to six. The approximation of form to the adult larva here is obvious.

Fig. 6.—The adult apterous viviparous female as seen in autumn, when she has almost ceased to produce young.

Fig. 7.—Head, rostrum, frontal tubercles, and seven-jointed antennæ of the winged female.

PLATE I.



Siphonophora rosæ.

G. B. Buckton del. et lith.

W. West & Co. imp.

PLATE II.

Siphonophora rosæ. (Page 103).

Fig. 1.—Red variety of the apterous viviparous female.

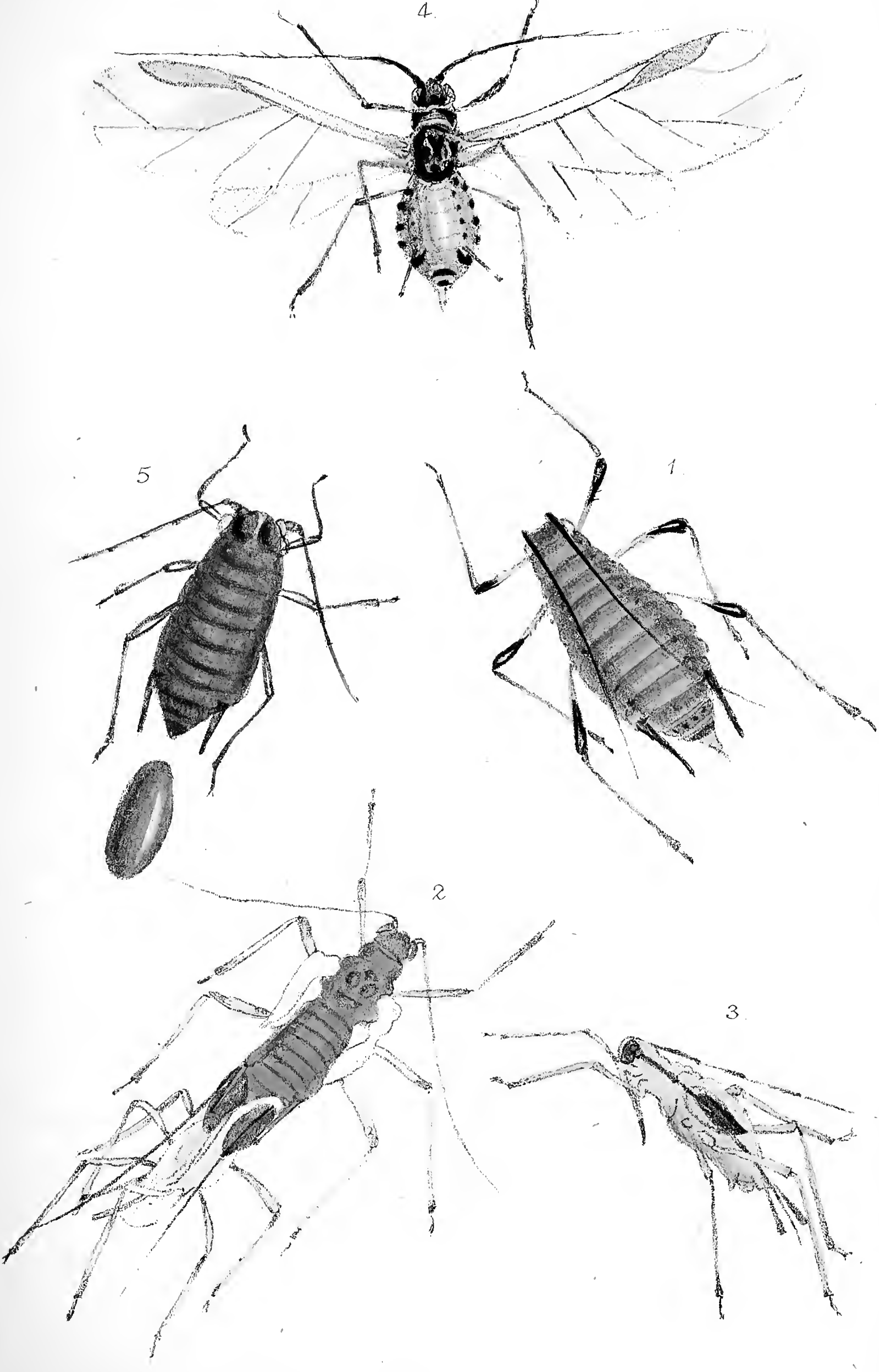
Fig. 2.—Imago emerging from the pupal sheath. The wings are in a soft, pulpy condition, but attain their full size in about twenty minutes if the day be warm and insect active.

Fig 3.—The empty sheath, which is complete, even to the covering of the eyes, the tips of the antennæ, and the claws. These sheaths usually stand erect on the leaves after the fly has flown.

Fig. 4.—The winged viviparous female.

Fig. 5.—The apterous oviparous female with her newly laid egg.

PLATE II.



Siphonophora ròsæ.

G.B. Buckton del. et lith.

W. West & C^o imp.

PLATE III.

SIPHONOPHORA ROSÆ, *var.* GLAUCA. (Page 109.)

Fig. 1.—Apterous viviparous female. Early pupal stage.

Fig. 2.—Profile view of winged viviparous female. *a.* Anal aperture. *b.* Vaginal aperture. *c.* Cauda.

Fig. 3.—Pupa. *w. w.* Wing-cases.

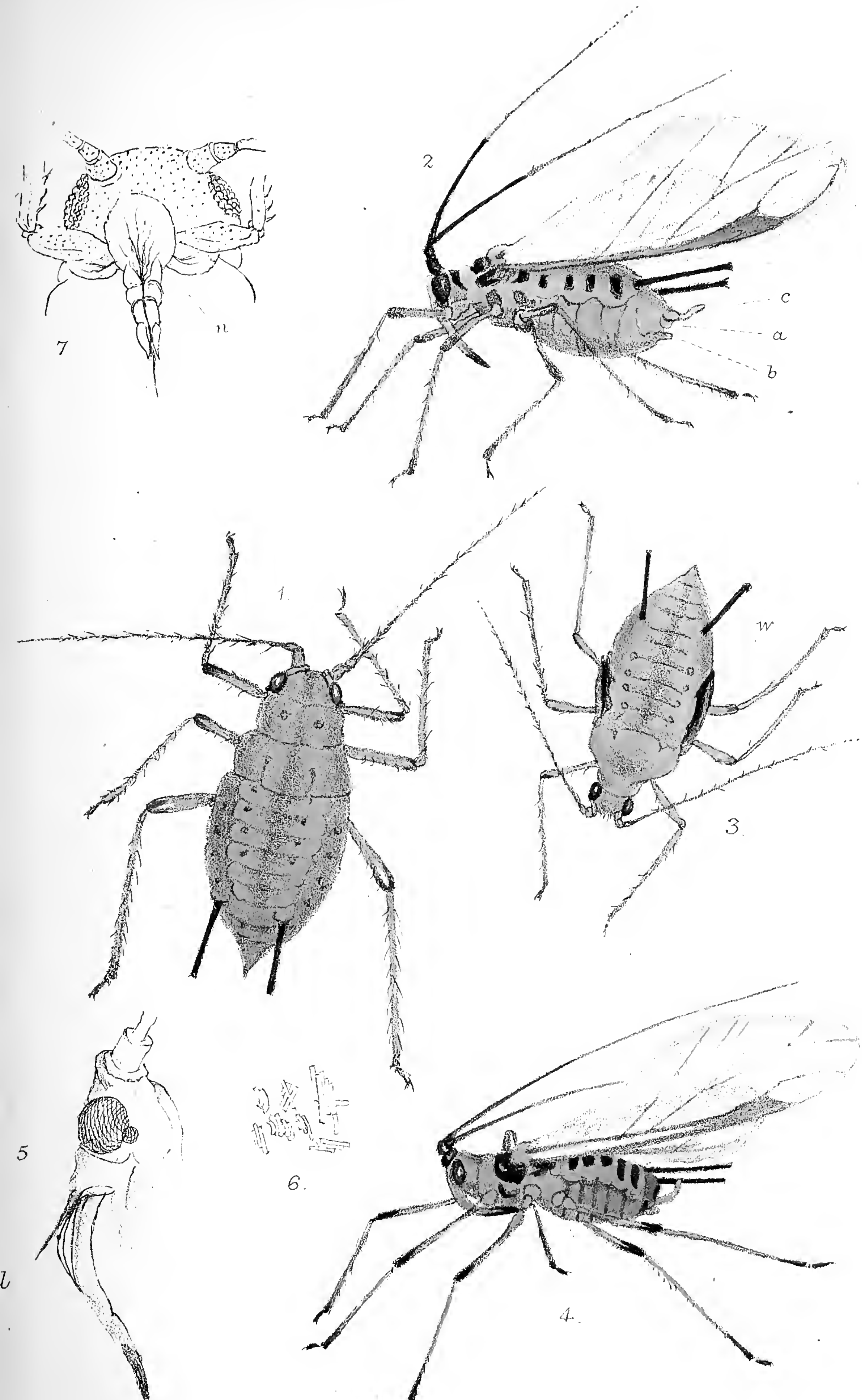
Fig. 4.—Winged male of *S. rosæ*,—not var. *glauca*.

Fig. 5.—Profile of the head of winged female, showing, *o*, the supplementary eye or ocellus; *l*, the labrum and the setæ partly lying in their sheath.

Fig. 6.—Portion of the mealy fibrous coat covering the body, giving it the glaucous tint. Greatly magnified.

Fig. 7.—Head and short rostrum of a very young individual born in October; *n*, the ramifying nerves connected with the rostrum.

PLATE III.



Siphonophora rosæ. var. glauca.

G. B. Buckton del. et lith

W. West & C° imp.

PLATE IV.

Siphonophora rosæ and Aphidius cancellatus.
(Page 111.)

Fig. 1.—Young of *S. rosæ* as it appeared immediately after its birth, August 9th.

Fig. 2.—Shining skin of a living larva of the same species which contains a parasite. The dorsum has commenced to swell and to show a pseudo-plating or segmentation.

Fig. 3.—Chitinous shell of an Aphis larva, after the escape of an Aphidius. The operculum often is found near the shell.

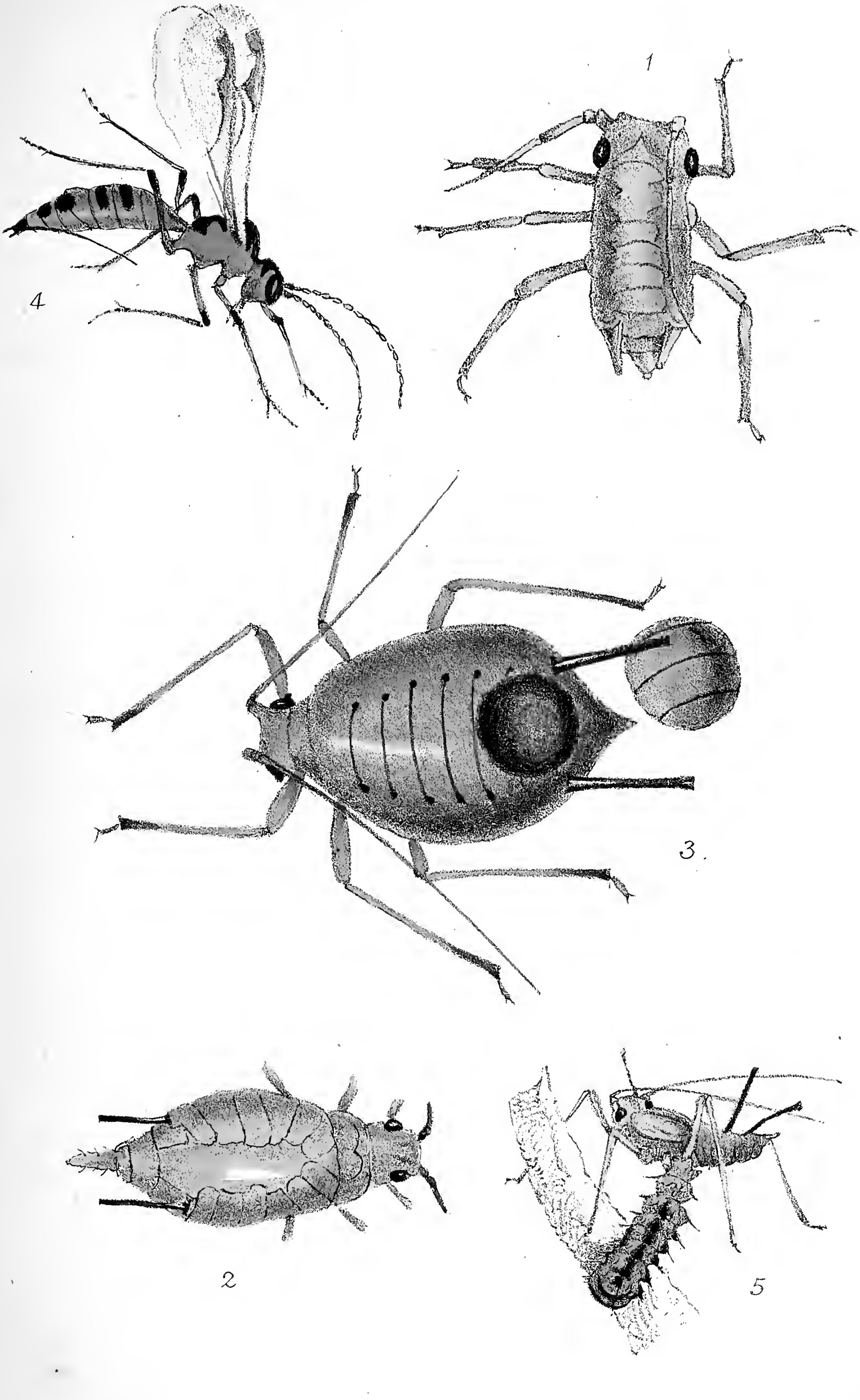
Fig. 4.—Imago of an Aphidius which, on August 26th, was bred from the above larva, and had issued from the aperture in its back.

As this insect appears to be undescribed, I give the following characters :

Head globose. 3 stemmata on the occiput. Antennæ long, with 17 joints. Palpi 3-jointed. Thorax fine yellow, with a large brown patch between the wings, followed by 3 bars. Abdomen fusiform, and attached by a fine pedicle, yellow, with four or five brown dorsal spots. Tarsi 5-jointed. Wings with a large triangular closed costal cell, and one large nervure.

Fig. 5.—The larva of a Syrphus which has just seized an Aphis, in order to suck out its contents.

PLATE IV.



Siphonophora rosæ 1–3.
Aphidius cancellatus 4. Syrphus 5.

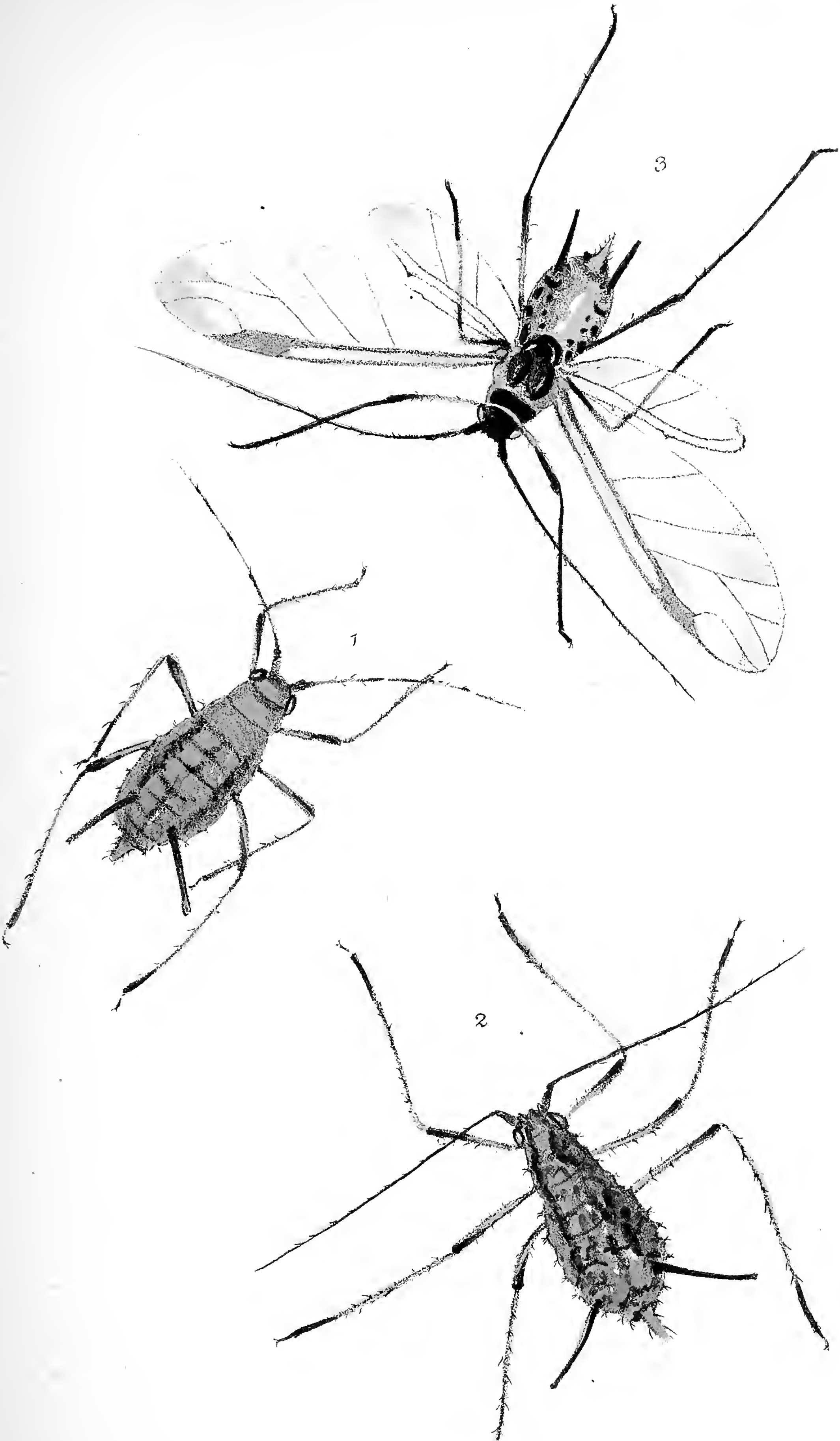
G. B. Buckton del. et lith. W. West & Co. imp.

PLATE IV (*bis*).

SIPHONOPHORA SCABIOSÆ. (Page 112.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Variety of the same ; an older specimen.
Fig. 3.—Winged viviparous female.

PLATE IV (*Bis.*)



Siphonophora Scabiosæ

G. B. Buckton del. et lith.

W. West & Co. imp.

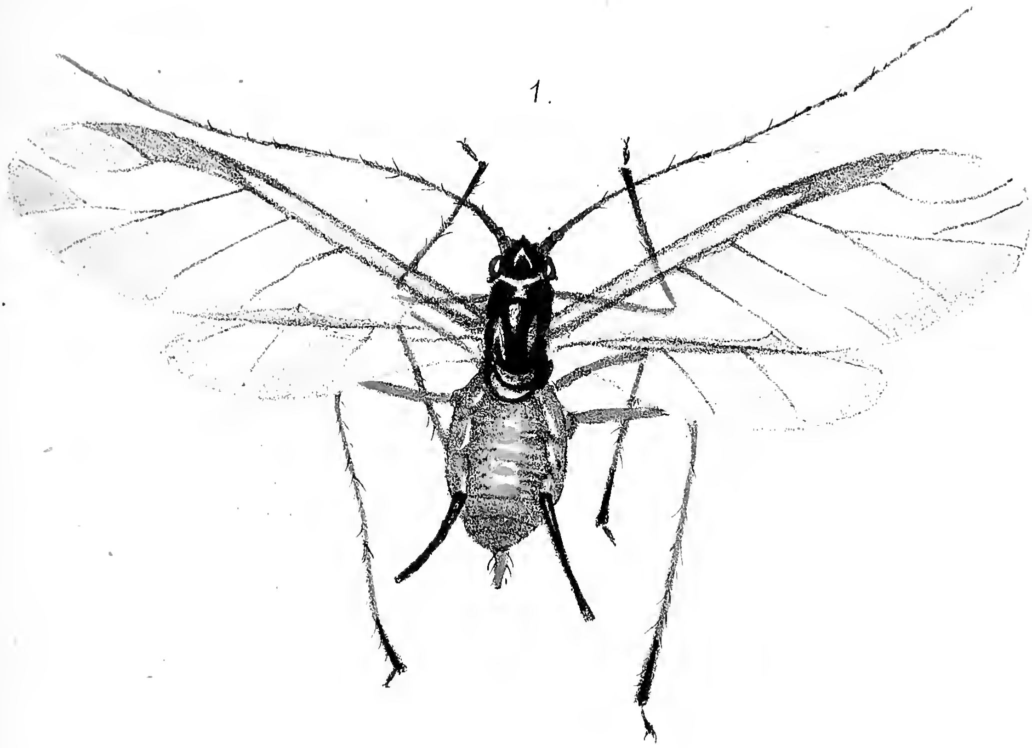
PLATE V.

SIPHONOPHORA CYPARISSIÆ. (Page 113.)

Fig. 1.—Winged viviparous female.
Fig. 2.—Apterous viviparous female.

PLATE V.

1.



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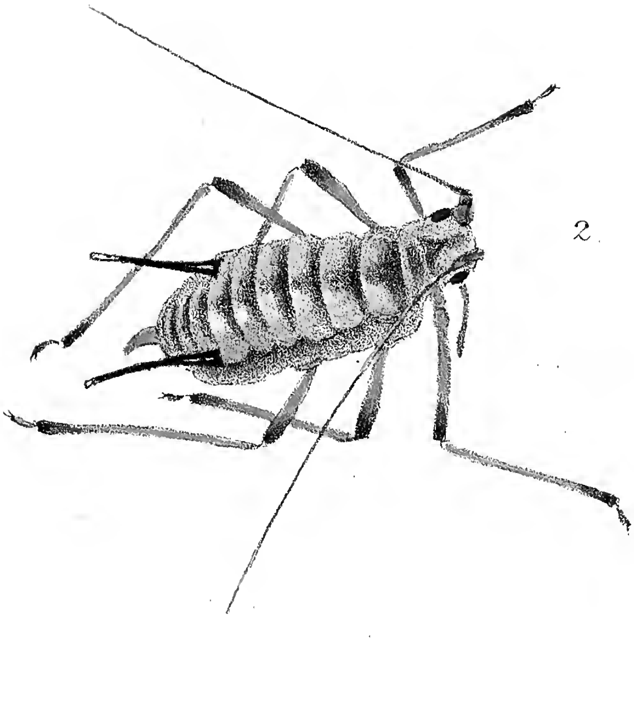


Siphonophora cyparissiæ.

G. B. Buckton del. et lith.

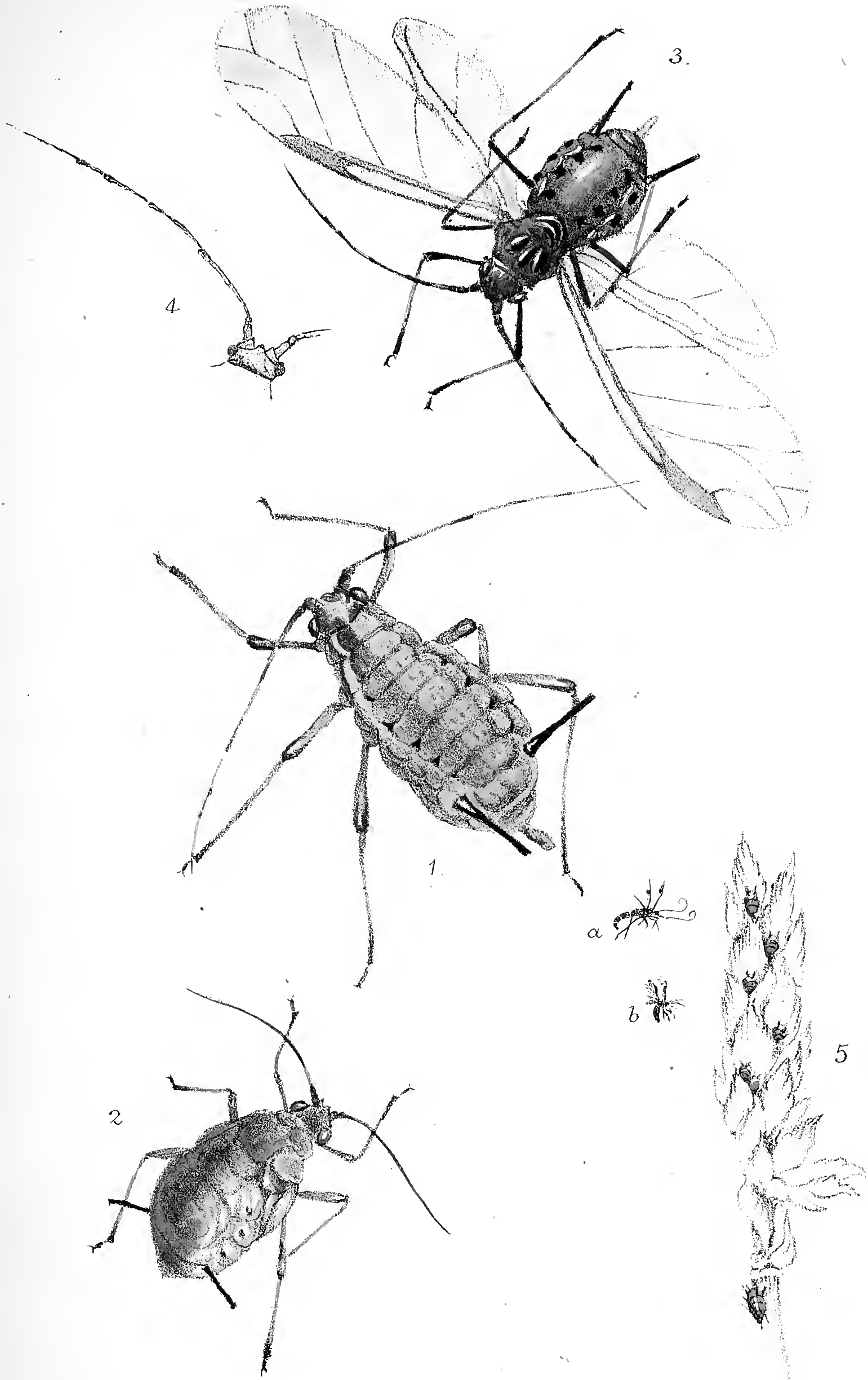
W. West & C° imp.

PLATE VI.

Siphonophora granaria. (Page 114.)

Fig. 1—Apterous viviparous female.
Fig. 2.—Pupa.
Fig. 3.—Winged viviparous female.
Fig. 4.—Head and antennæ of the same.
Fig. 5.—Part of an ear of wheat studded with Aphides which have been struck by an Ephedrus. *a. Ephedrus plagiator*, natural size. *b. Ceraphron Carpenteri*, natural size.

PLATE VI.



Siphonophora granaria.

G. B. Buckton del. et lith.

W. West & C° imp.

PLATE VII.

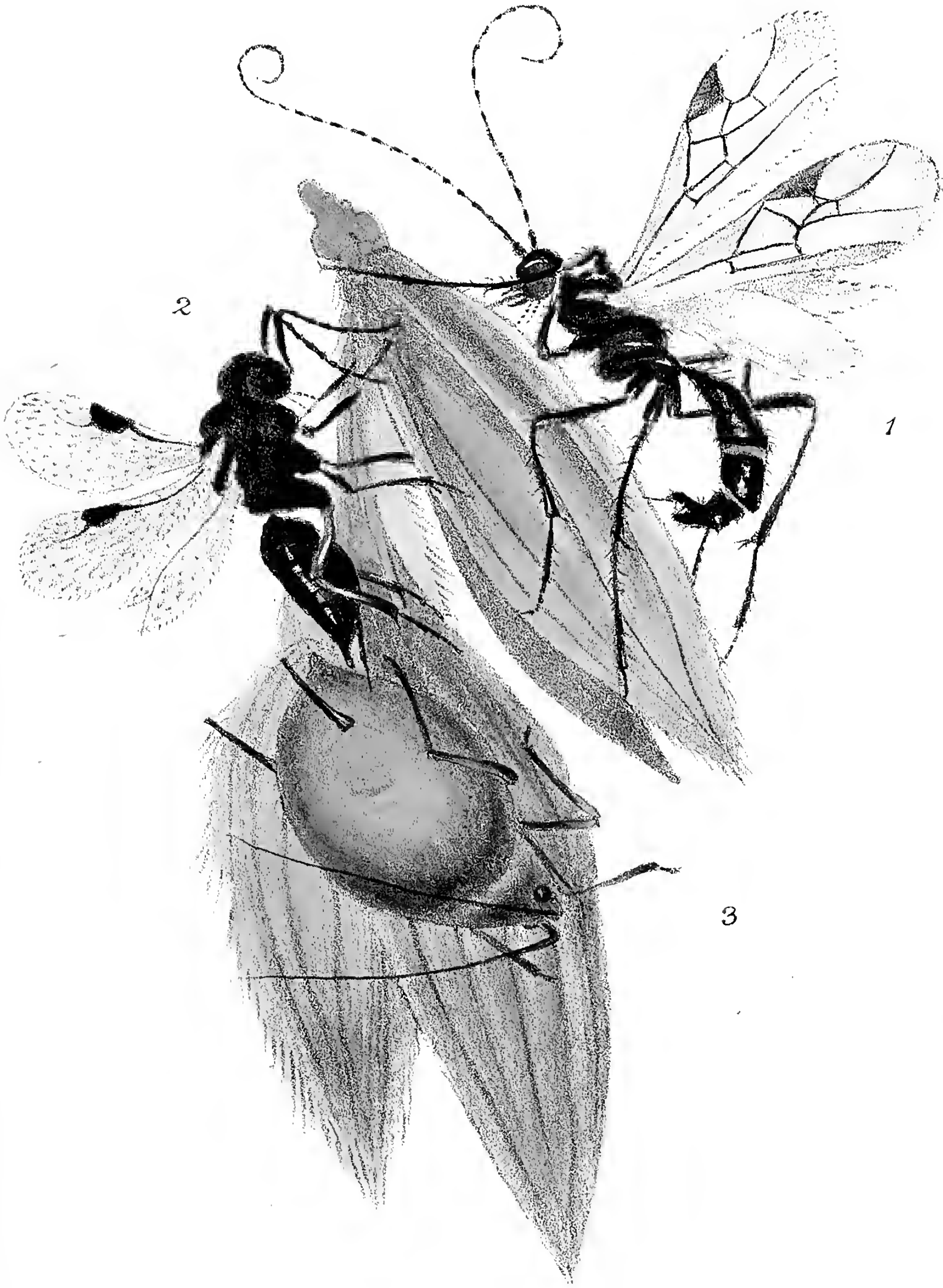
Siphonophora granaria, Ephedrus, and Coryne.
(Page 117.)

Fig. 1.—*Ephedrus plagiator* which has laid her egg in the larva of *Siphonophora granaria*.

Fig. 2.—*Coryne Carpenteri* commencing to pierce the larva of *S. granaria*, which is already infested by the maggot hatched from the egg of Ephedrus. This maggot will in turn form the food of the grub of Coryne.

Fig. 3.—The larva of *S. granaria* infested by *Ephedrus plagiator*.

PLATE VII.



Ephedrus plagiator 1. Coryne carpenteri 2.
Siphonophora granaria 3.

G. B. Buckton del. et lith.

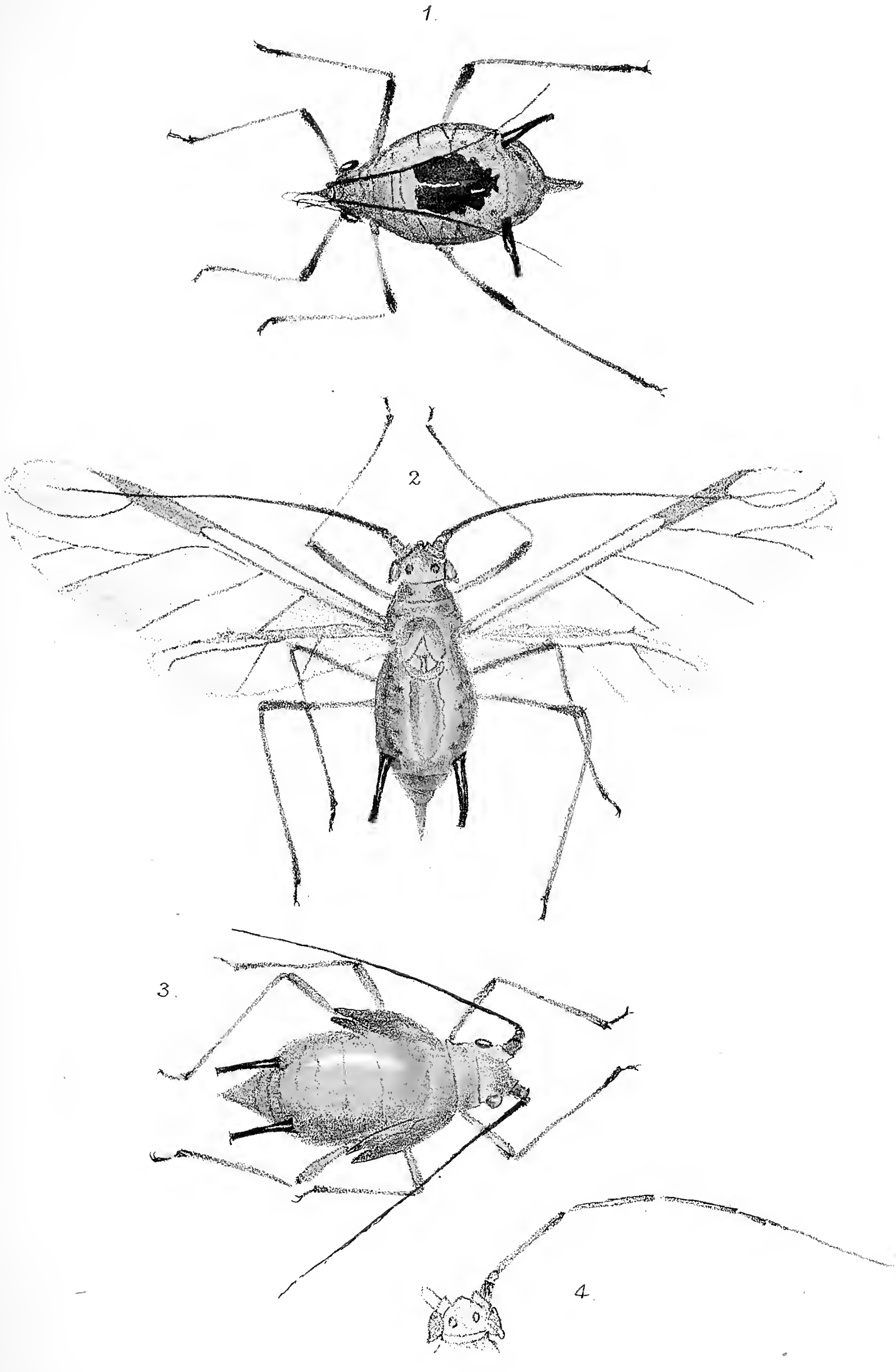
W. West & C° imp.

PLATE VIII.

Siphonophora lutea. (Page 119.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Winged viviparous female.
Fig. 3.—Pupa.
Fig. 4.—Head and antennæ of the imago.

PLATE VIII.



Siphonophora lutea.

G.B. Buckton del. et lith. W. West & C.° imp.

PLATE IX.

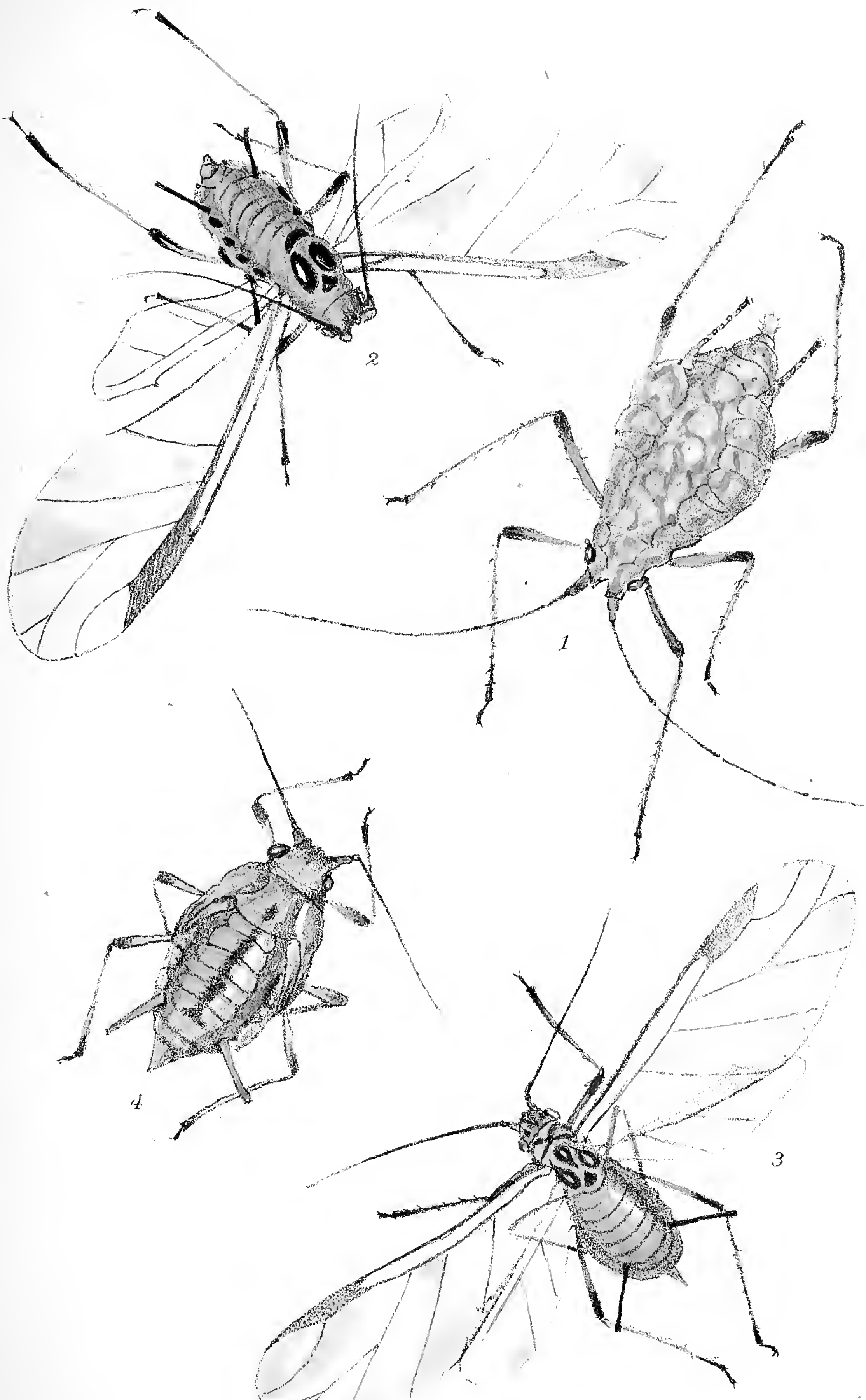
Siphonophora menthæ. (Page 120.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Winged viviparous female of the same.

Siphonophora chelidonii. (Page 121.)

Fig. 3.—Winged viviparous female.
Fig. 4.—Pupa of the same.

PLATE IX.



Siphonophora menthæ 1-2.
S. chelidonii 3-4.

G. B. Buckton del et lith.

W. West & C.° imp.

PLATE X.

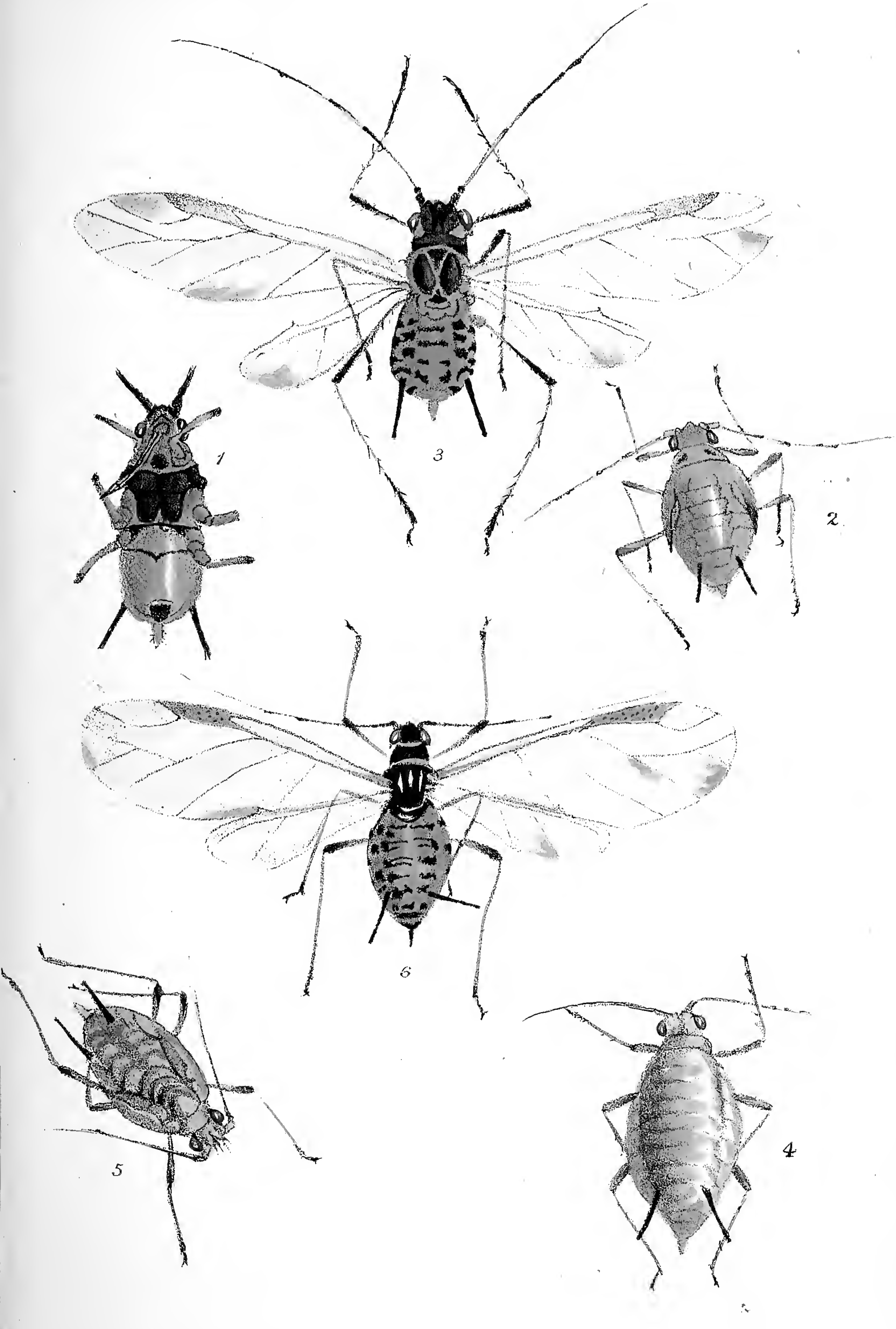
Siphonophora polygoni. (Page 123.)

Fig. 1.—Under side of the winged female.
Fig. 2.—Pupa.
Fig. 3.—Winged viviparous female.

Siphonophora alliariæ. (Page 123.)

Fig. 4.—Apterous viviparous female.
Fig. 5.—Pupa.
Fig. 6.—Winged viviparous female.

PLATE X.



Siphonophora polygoni 1–3.

G. B. Buckton del. et lith. S. alliariœ 4–6. W. West & C.º imp.

PLATE XI.

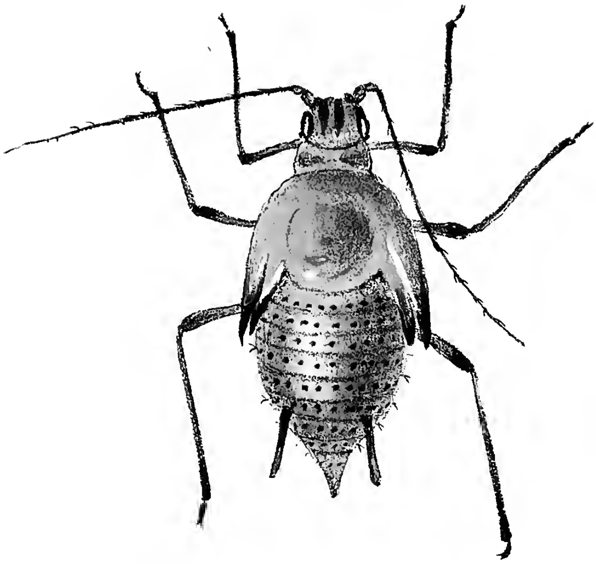
Siphonophora hieracii. (Page 126.)

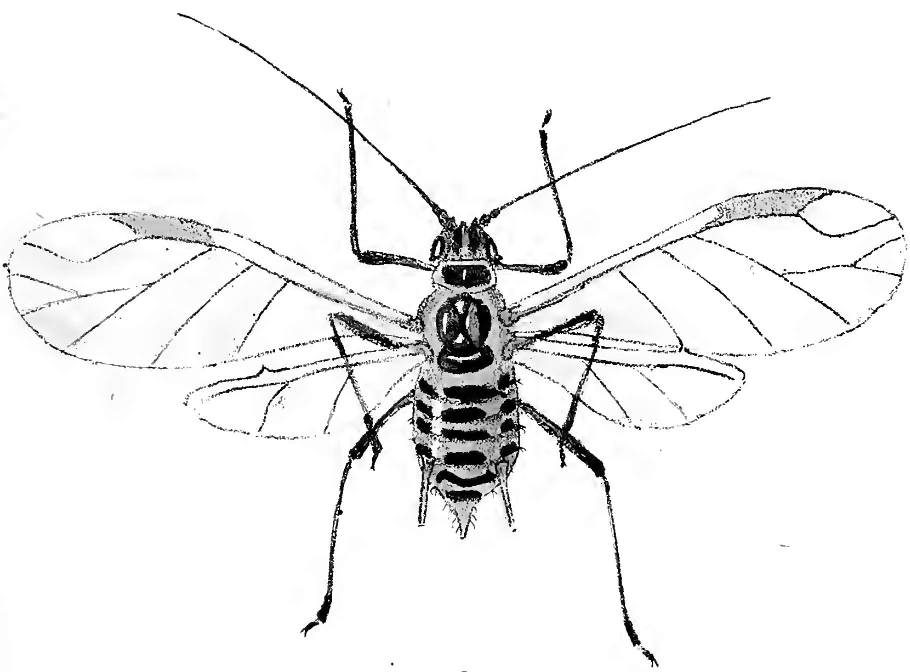
Fig. 1.—The pupa.

Fig. 2.—The winged viviparous female which subsequently emerged from the above pupa.

PLATE XI.

1





2

Siphonophora hieracii.

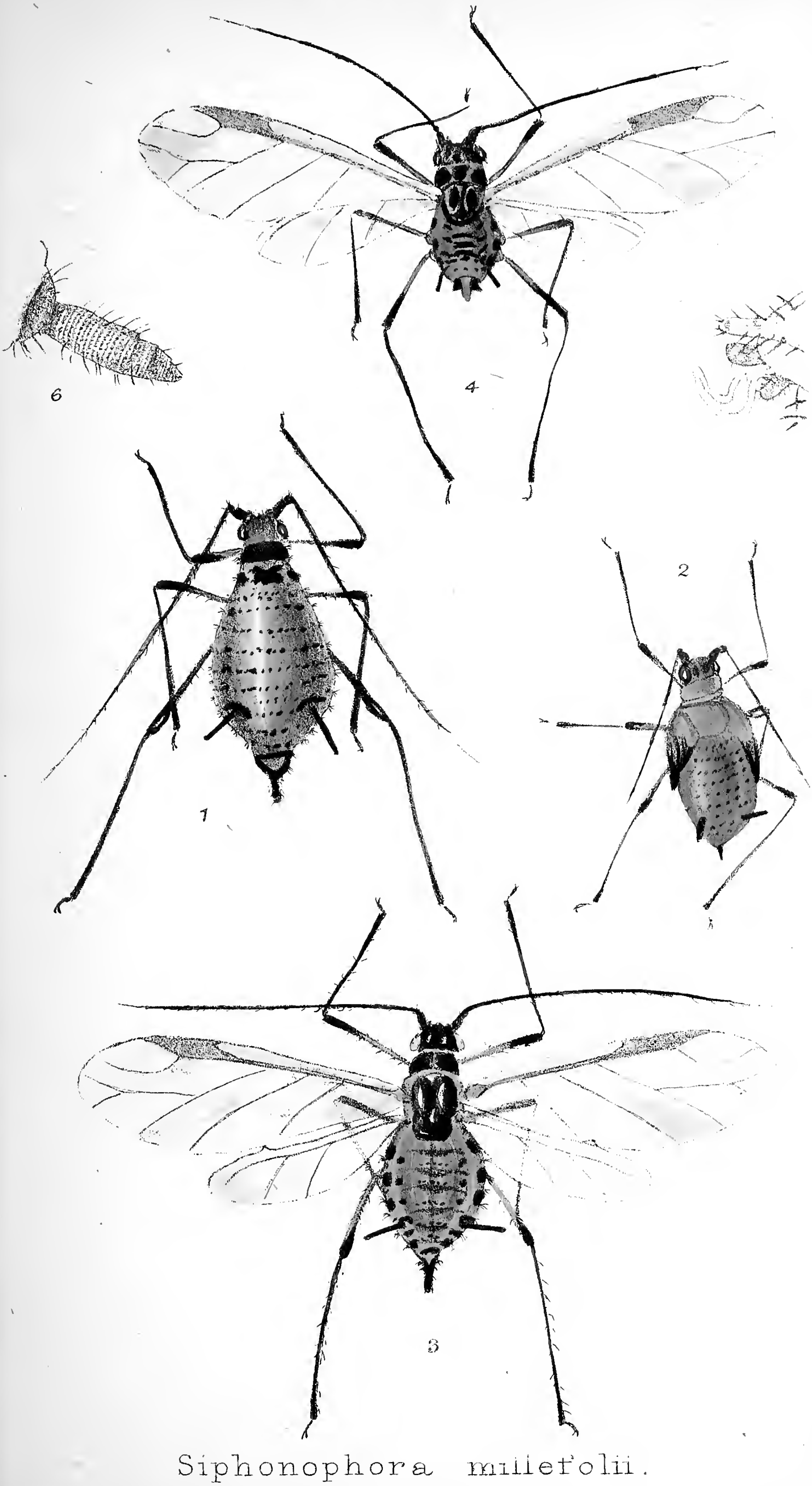
G. B. Buckton del et lith. W. West & Co. imp.

PLATE XII.

SIPHONOPHORA MILLEFOLII. (Page 127.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Pupa of the male.
Fig. 3.—Winged viviparous female.
Fig. 4.—Winged male.
Fig. 5.—Posterior portion of the abdominal rings of the male viewed from above, showing the tail, the protruded penis, and the two papillæ or claspers.
Fig. 6.—Tail and anal aperture of the same insect.

PLATE XII.



Siphonophora millefolii.

G.B.Buckton del. et lith.

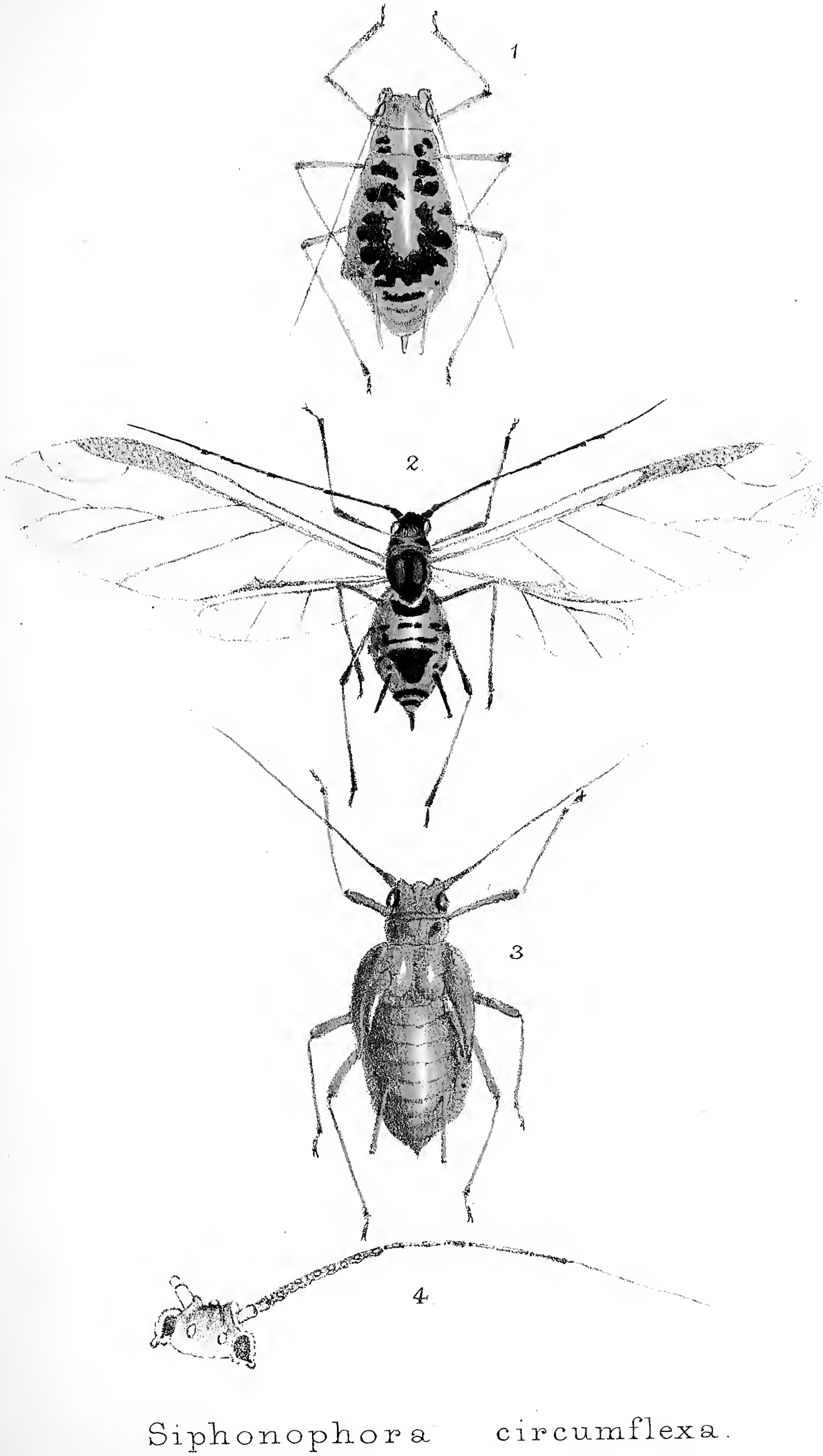
W.West & Co. imp.

PLATE XIII.

SIPHONOPHORA CIRCUMFLEXA. (Page 130.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Winged viviparous female.
Fig. 3.—Pupa.
Fig. 4.—Head and antennæ of the winged female. The third antennal joint is tuberculate.

PLATE XIII.



Siphonophora circumflexa.

G.B.Buckton del. et lith.

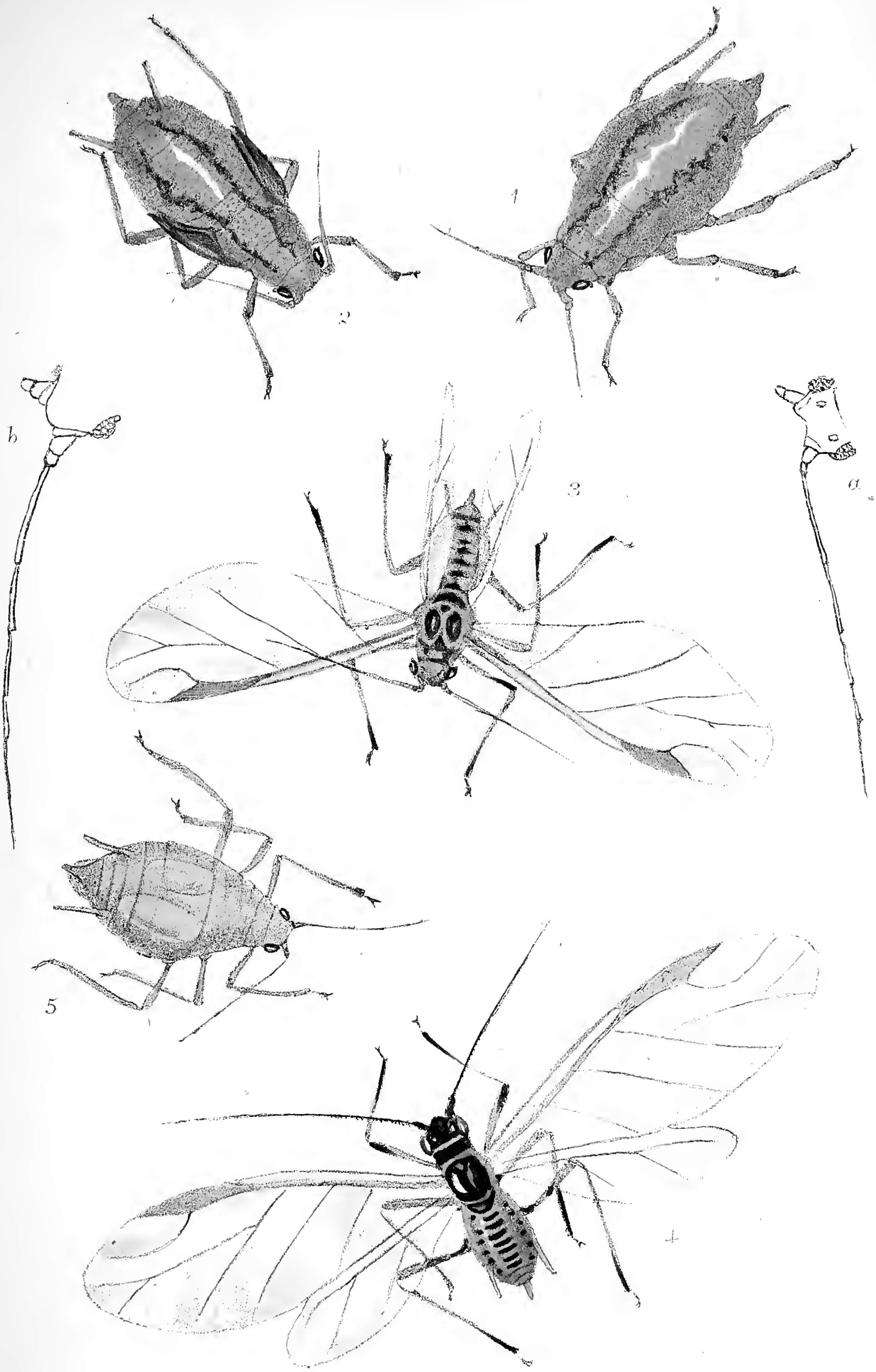
W.West & Co. imp.

PLATE XIII (*bis*).

SIPHONOPHORA DIRHODA. (Page 132.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Pupa.
Fig. 3.—Winged female.
Fig. 4.—Winged male. *a.* The head and antenna of the same.
Fig. 5.—Oviparous female, showing two ova within, nearly ready for laying. *b.* The head and antenna of the same insect.

PLATE XIII. bis.



Siphonophora dirhoda.

G. B. Buckton del. et lith.

W. West & Co. imp.

PLATE XIV.

SIPHONOPHORA PISI. (Page 134.)

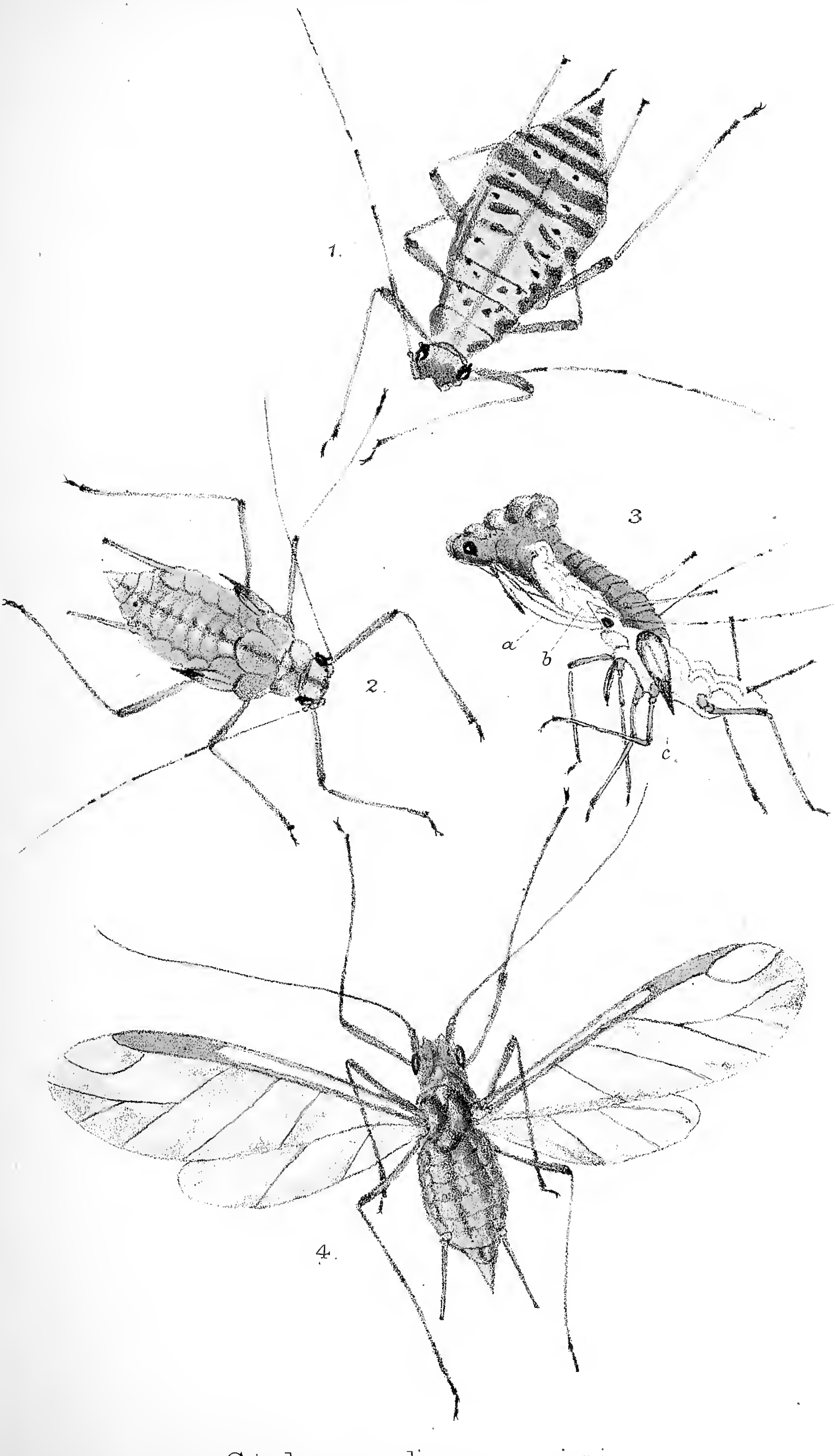
Fig. 1.—Apterous viviparous female with its glaucous coat.

Fig. 2.—Pupa.

Fig. 3.—Imago emerging from the pupa. *a*. The antennæ which have just been extracted from their sheaths. These last are left empty, even to their extreme joints. *b*. The wings in a soft pulpy condition similarly extricated from their wing-cases, *c*. The winged insect grows very rapidly, probably from the imbibition of air into the tracheæ.

Fig. 4.—Winged viviparous female.

PLATE XIV.



Siphonophora pisi.

G. B. Buckton del et lith.

W. West & C^o imp.

PLATE XV.

SIPHONOPHORA PELARGONII. (Page 136.)

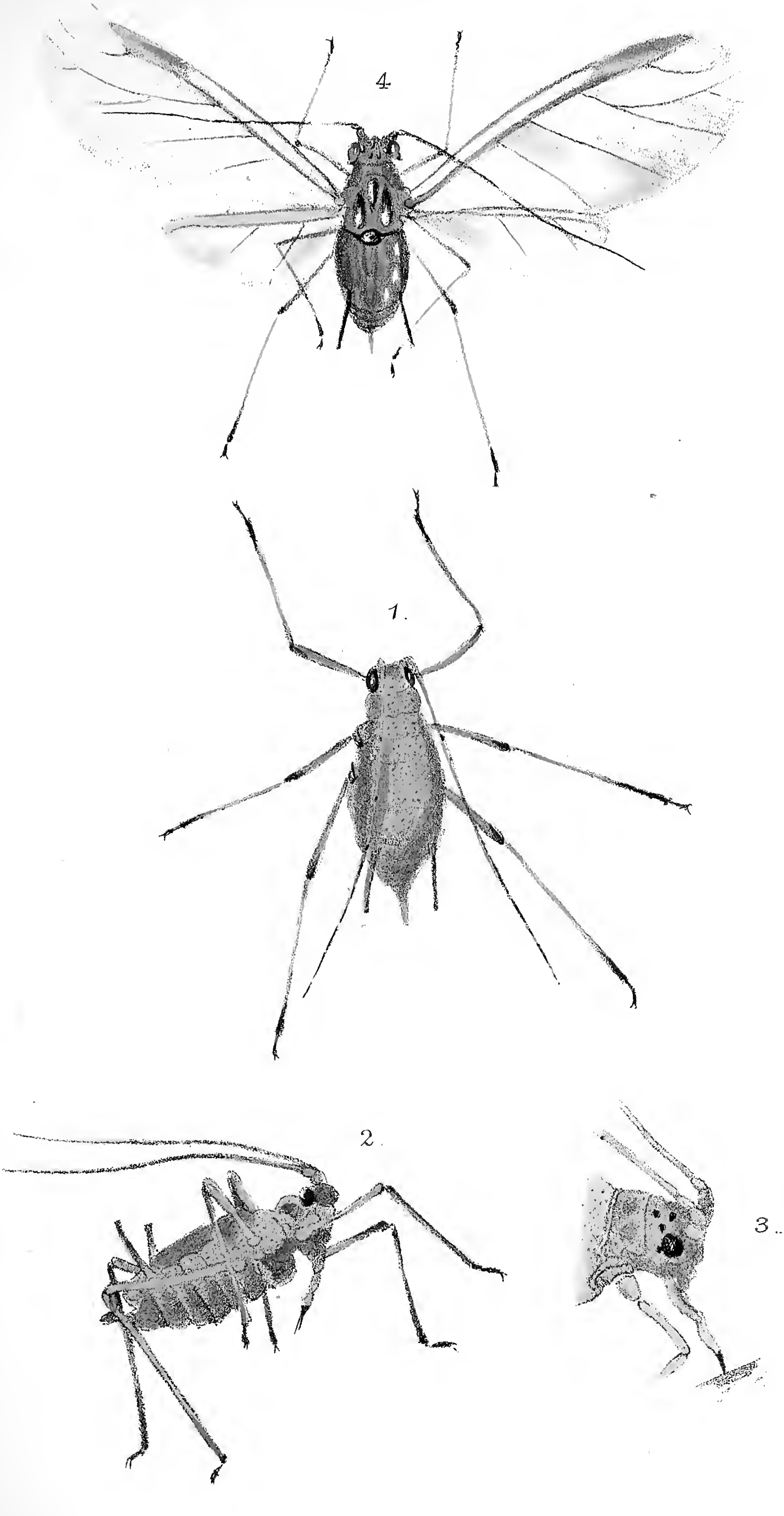
Fig. 1.—Apterous viviparous female.

Fig. 2.—Profile view of the same.

Fig. 3.—Head and proboscis of the winged viviparous female, showing that during suction the point only is pressed upon the surface, whilst the setæ enter the soft parenchyma of the leaf. This specimen showed the abnormal number of seven stemmata.

Fig. 4.—Winged viviparous female.

PLATE XV.



Siphonophora pelargonii.

G. B. Buckton del et lith. *W. West & C^o. imp.*

PLATE XVI.

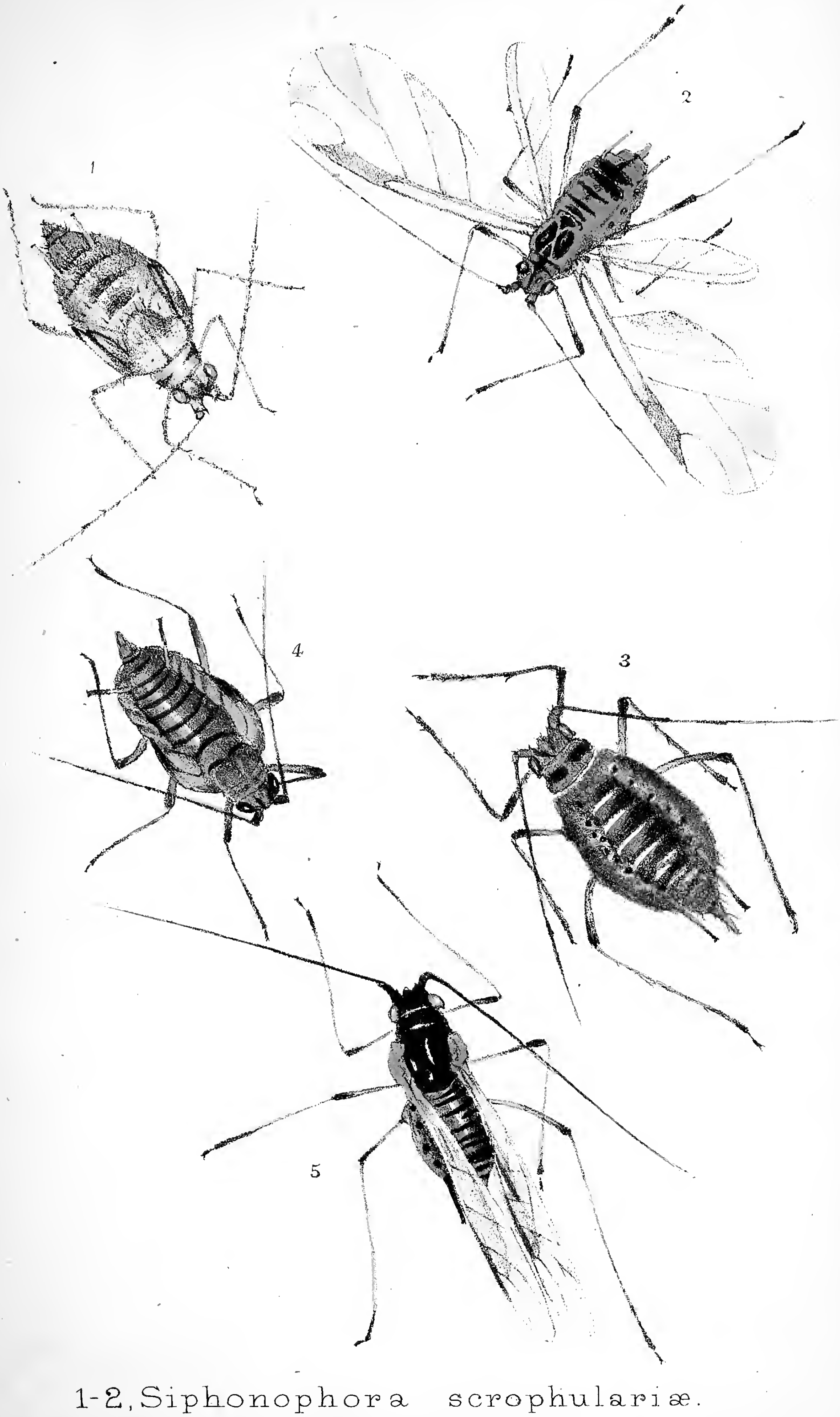
Siphonophora scrophulariæ. (Page 137.)

Fig. 1.—Pupal form of the viviparous female.
Fig. 2.—Winged viviparous female.

Siphonophora lactucæ. (Page 139.)

Fig. 3.—Apterous viviparous female.
Fig. 4.—Pupa.
Fig. 5.—Winged viviparous female.

PLATE XVI.



1-2, Siphonophora scrophulariæ.
3-5, S. lactucæ.

G.B.Buckton del. et lith.

W.West & Co. imp.

PLATE XVII.

Siphonophora rubi. (Page 140.)

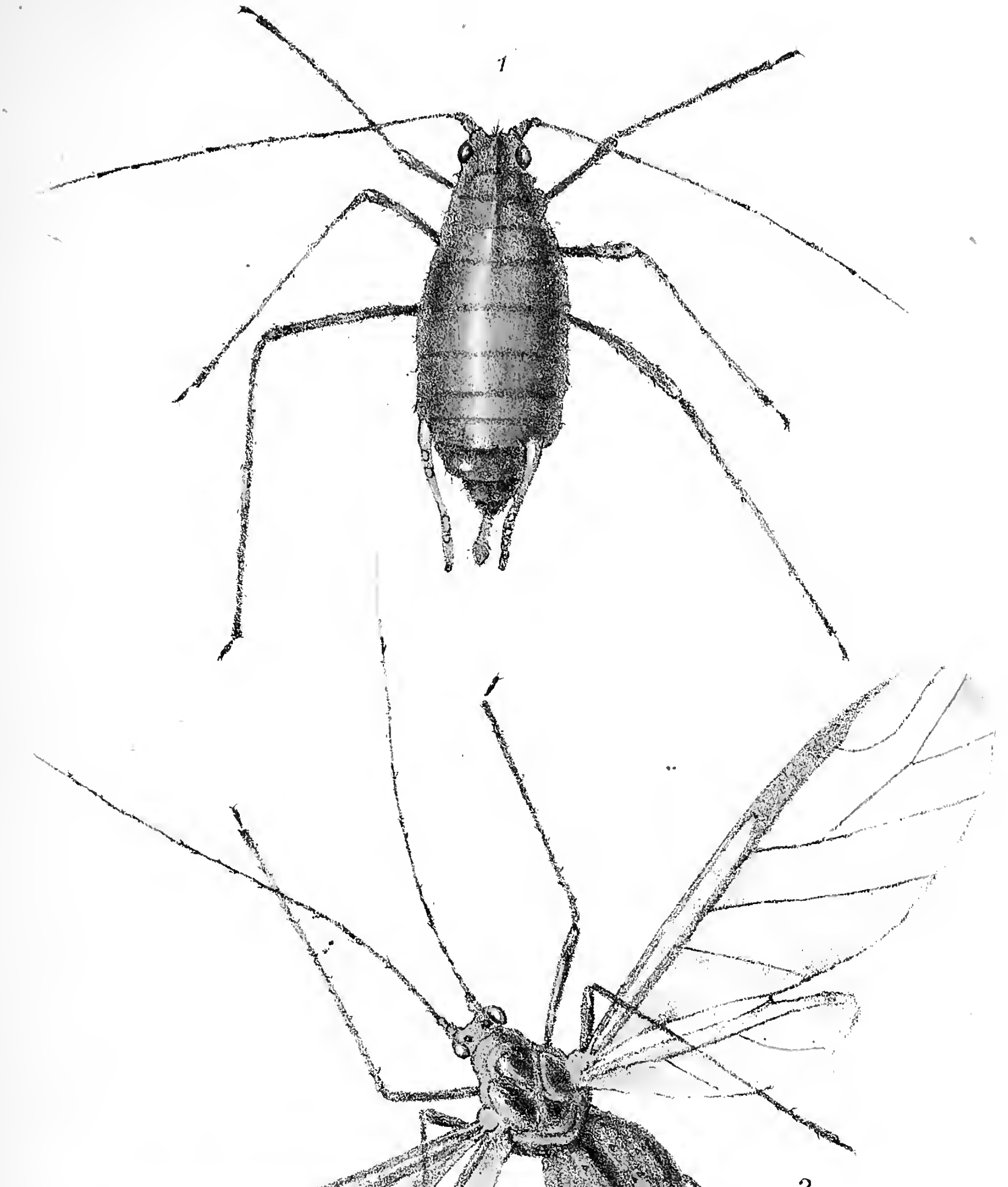
Fig. 1.—Apterous viviparous female.

Fig. 2.—Winged viviparous female.

Fig. 3.—Posterior abdominal rings, showing the clavate siphuncles. *a.* Anal aperture. *b.* Cornicles charged with honey dew. *b̄.* Vulva.

Fig. 4.—Portion of the head with (*s*) stemmata, frontal tubercles, and basal antennal joints. The bands of muscle which move the antennæ are shown.

PLATE XVII.



Siphonophora rubi.

G. B. Buckton del et lith.

W. West & C° imp.

PLATE XVIII.

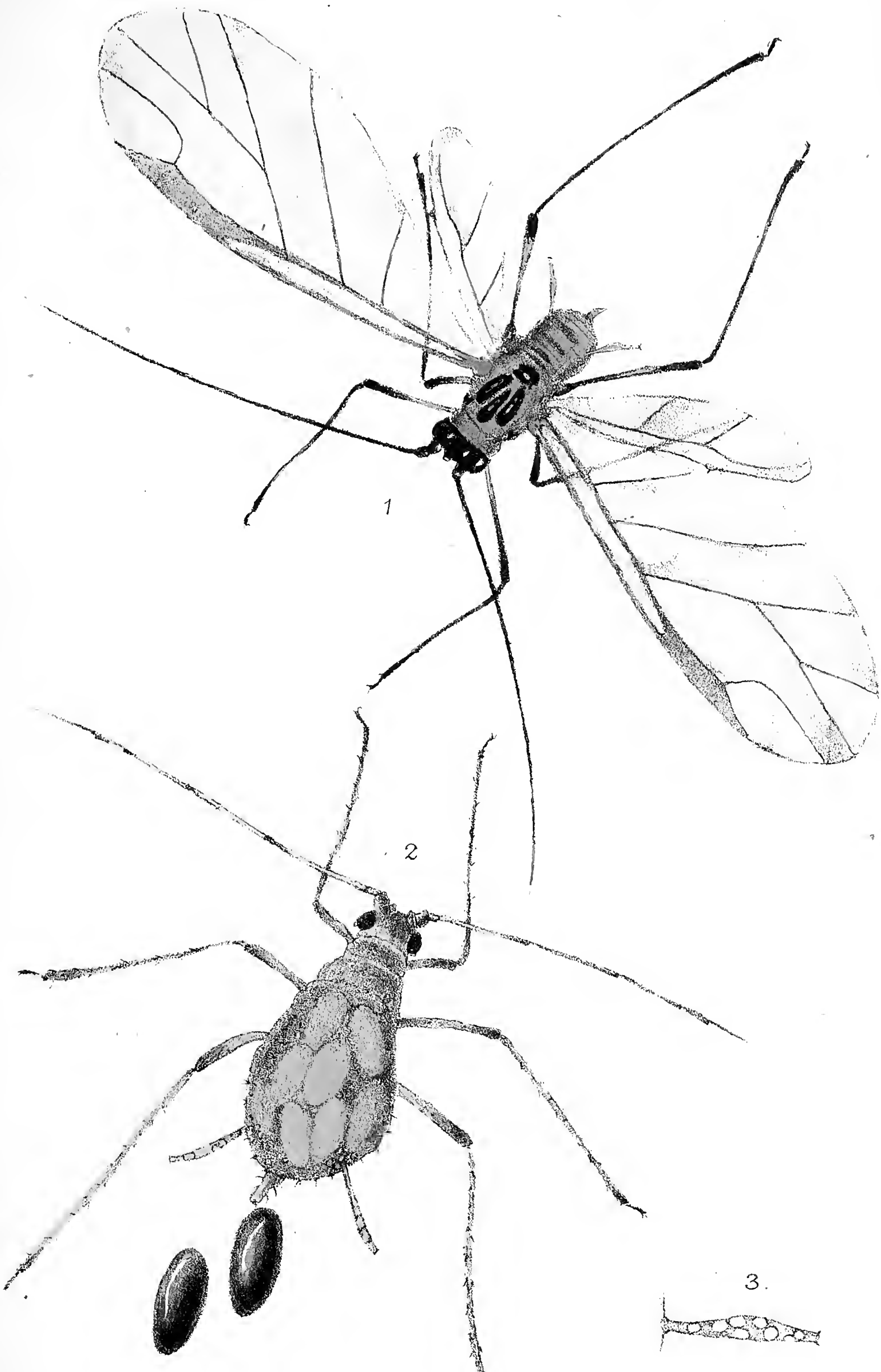
Siphonophora rubi. (Page 140.)

Fig. 1.—Winged male, showing the characteristic voluminous wings and attenuated abdomen of the insect.

Fig. 2.—Apterous oviparous female, which has deposited two eggs. Several ova in various stages of development may be seen through the transparent skin of the abdomen. Numerous oil-globules are congregated round the bases of the nectaries.

Fig. 3.—Enlarged view of the cornicle of the oviparous female.

PLATE XVIII.



Siphonophora rubi.

G. B. Buckton del. et lith.

W. West & Co. imp.

PLATE XIX.

Siphonophora urticæ. (Page 143.)

Fig. 1.—Apterous viviparous female, carinated, and marked with dorsal and lateral green stripes. Variety *a*.

Fig. 2.—Variety *β* of the same, con-colorous and not carinated.

Fig. 3.—Winged viviparous female.

Fig. 4.—Head and antennæ of the last insect.

PLATE XIX.

Siphonophora urticæ.

G.B. Buckton del. et lith.

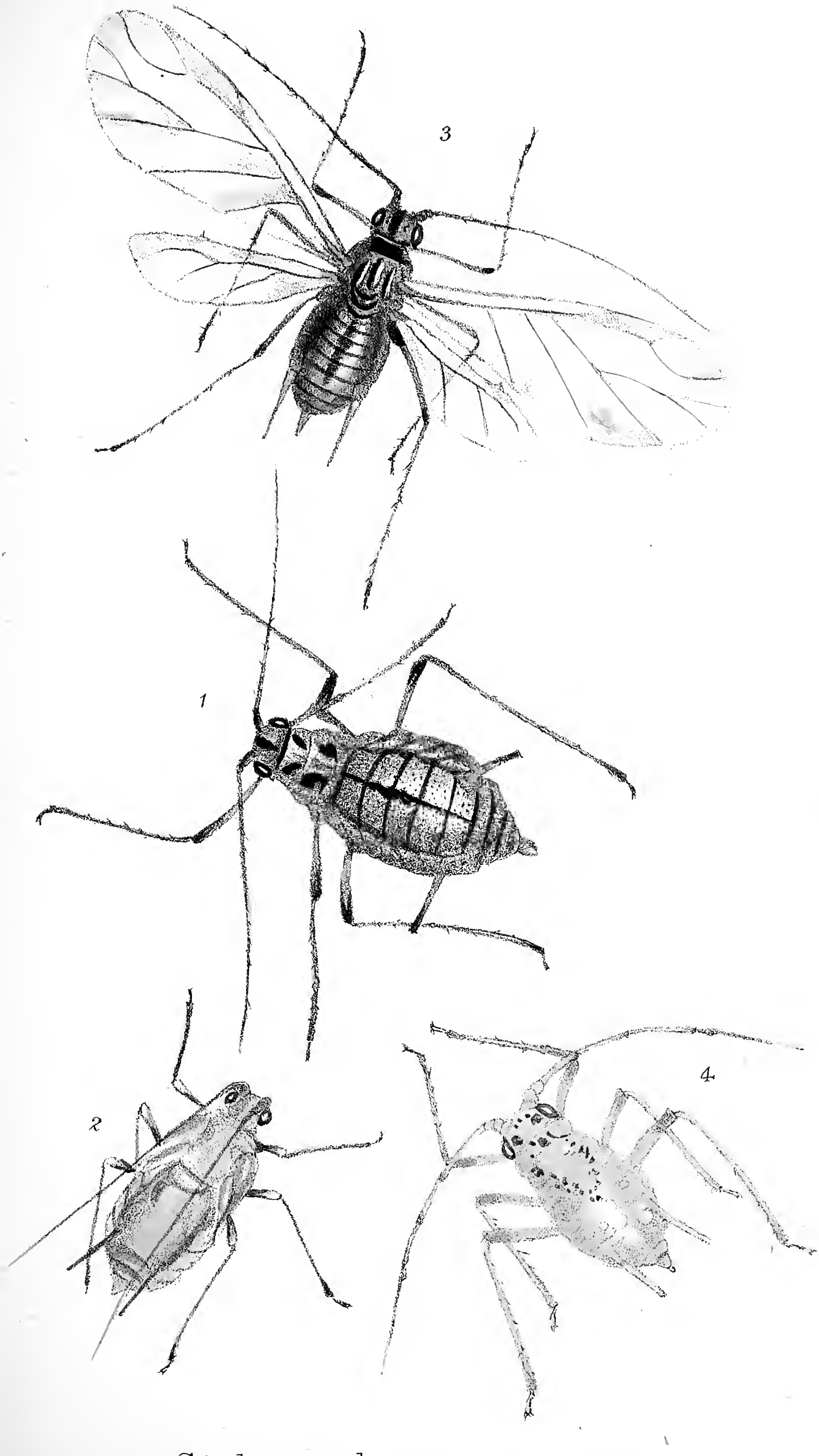
W. West & Co. imp.

PLATE XX.

Siphonophora carnosa. (Page 144.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Pupa.
Fig. 3.—Winged viviparous female.
Fig. 4.—Young specimen of *S. carnosa*, showing its thick yet partly developed antennæ. The body is crowded with colourless oil-globules.

PLATE XX.



Siphonophora carnosa.

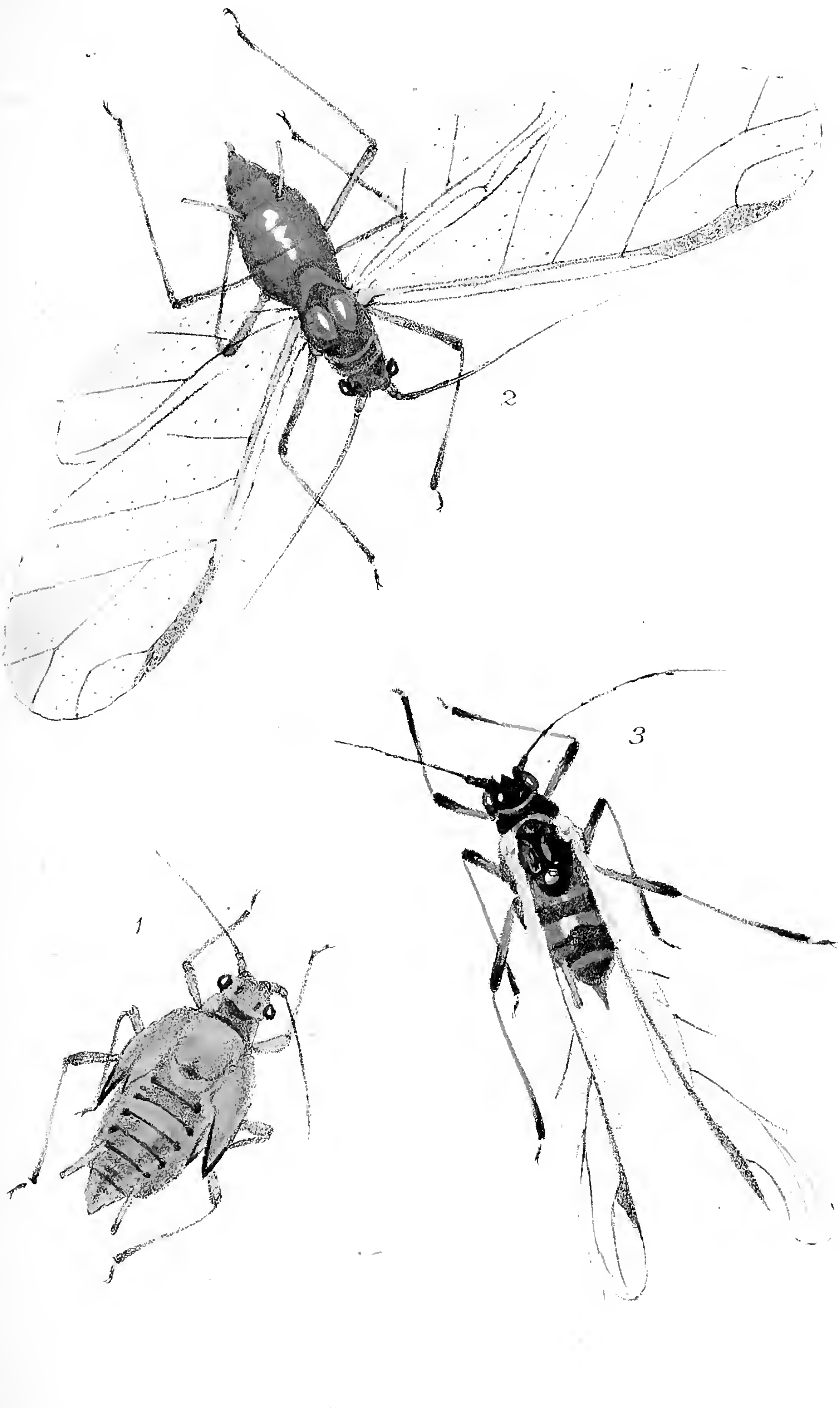
G. B. Buckton del. et lith. W. West & Co. imp.

PLATE XX (*bis*).

SIPHONOPHORA LONGIPENNIS. (Page 146.)

Fig. 1.—The pupa.
Fig. 2.—Winged viviparous female.
Fig. 3.—Winged male of the same.

PLATE XX. bis.



Siphonophora longipennis.

G. B. Buckton del. et lith. W. West & Cº imp.

PLATE XXI.

Siphonophora convolvuli. (Page 148.)

Fig. 1.—Apterous viviparous female. The red spots are the eyes of the embryos contained within the body.

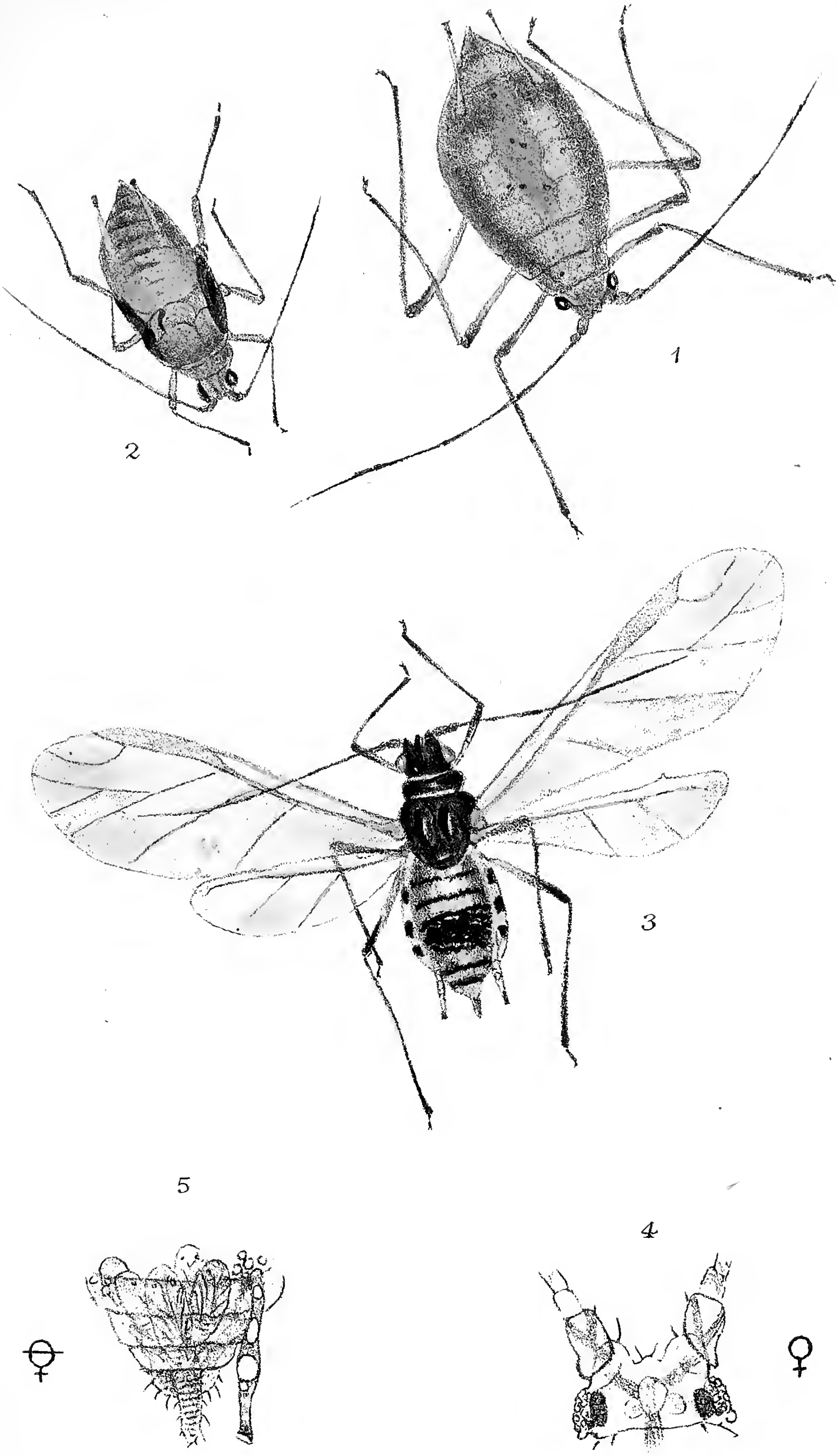
Fig. 2.—Pupa, which is considerably smaller than the larva.

Fig. 3.—Winged viviparous female.

Fig. 4.—Head and frontal tubercles of the apterous female. The muscles attached to the antennæ and rostrum are obvious.

Fig. 5.—Posterior abdominal rings of the viviparous female. The cornicles in both larva and imago are dilated in the middle. Several embryos are crowded about the caudal region ready for birth.

PLATE XXI.



Siphonophora convolvuli.

G. B. Buckton del. et lith. W. West & Co. imp.

PLATE XXII.

Siphonophora avellanæ. (Page 149.)

Fig. 1.—Apterous viviparous female.

Fig. 2.—Winged viviparous female.

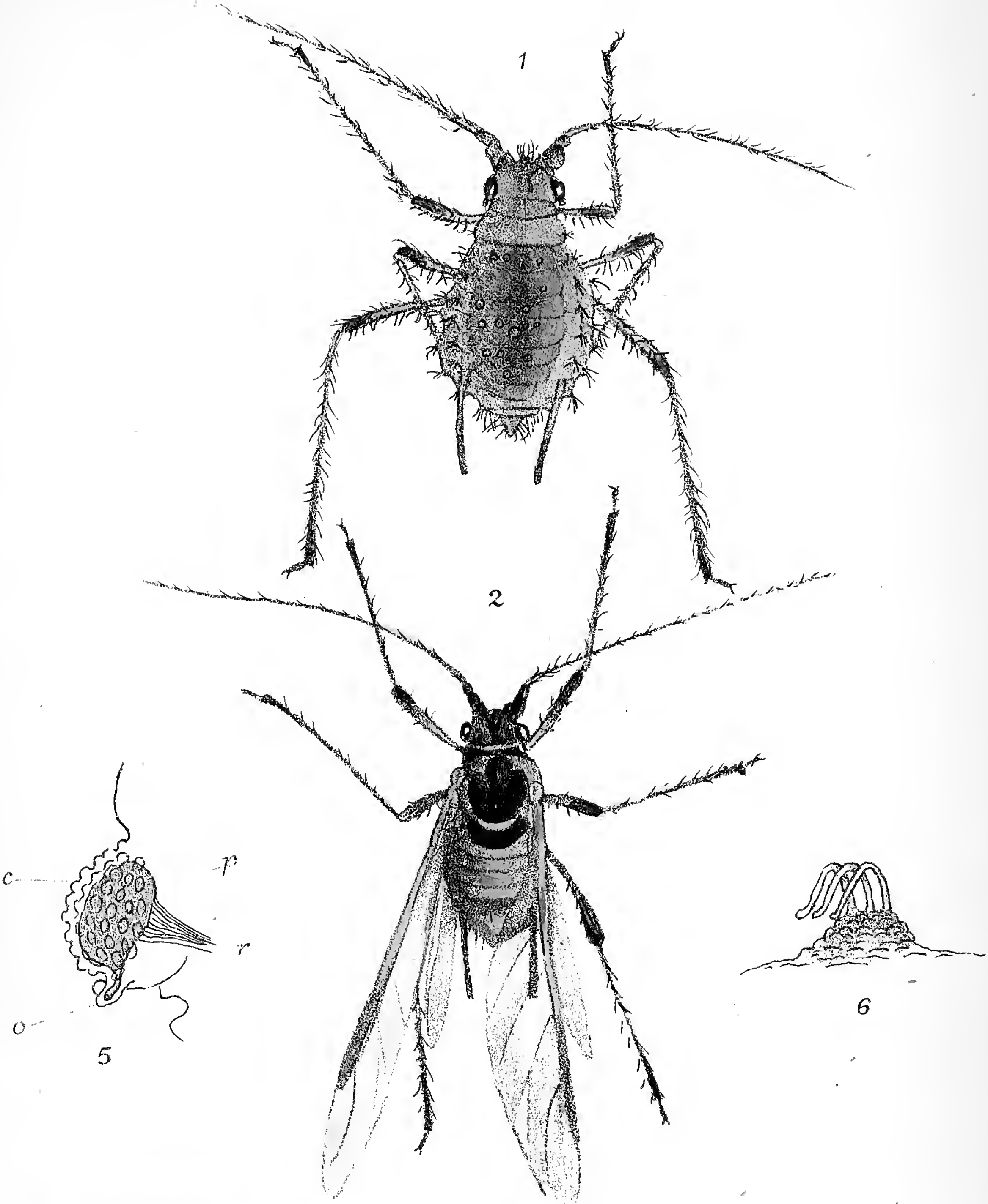
Fig. 3.—Upper and lower wings of the same.

Fig. 4.—Head and basal antennal joints of the imago. The nervous filaments supplied to the antennæ are shown.

Fig. 5.—Eye, greatly magnified, showing, *c*, the cornea, with its hemispherical lenses; *o*, the ocellus, with its special lens; *p*, the chorion, with its pigmental mass; *r*, the bundle of filaments, forming the optic nerve.

Fig. 6.—The imbricated papilla fixed on the costal margin of the hind wing. It is furnished with three bent hooks, which engage themselves in the fold of the upper wing during flight.

PLATE XXII.



Siphonophora avellanæ.

G. B. Buckton del. et lith. W. West & Co imp.

PLATE XXII (*bis*).

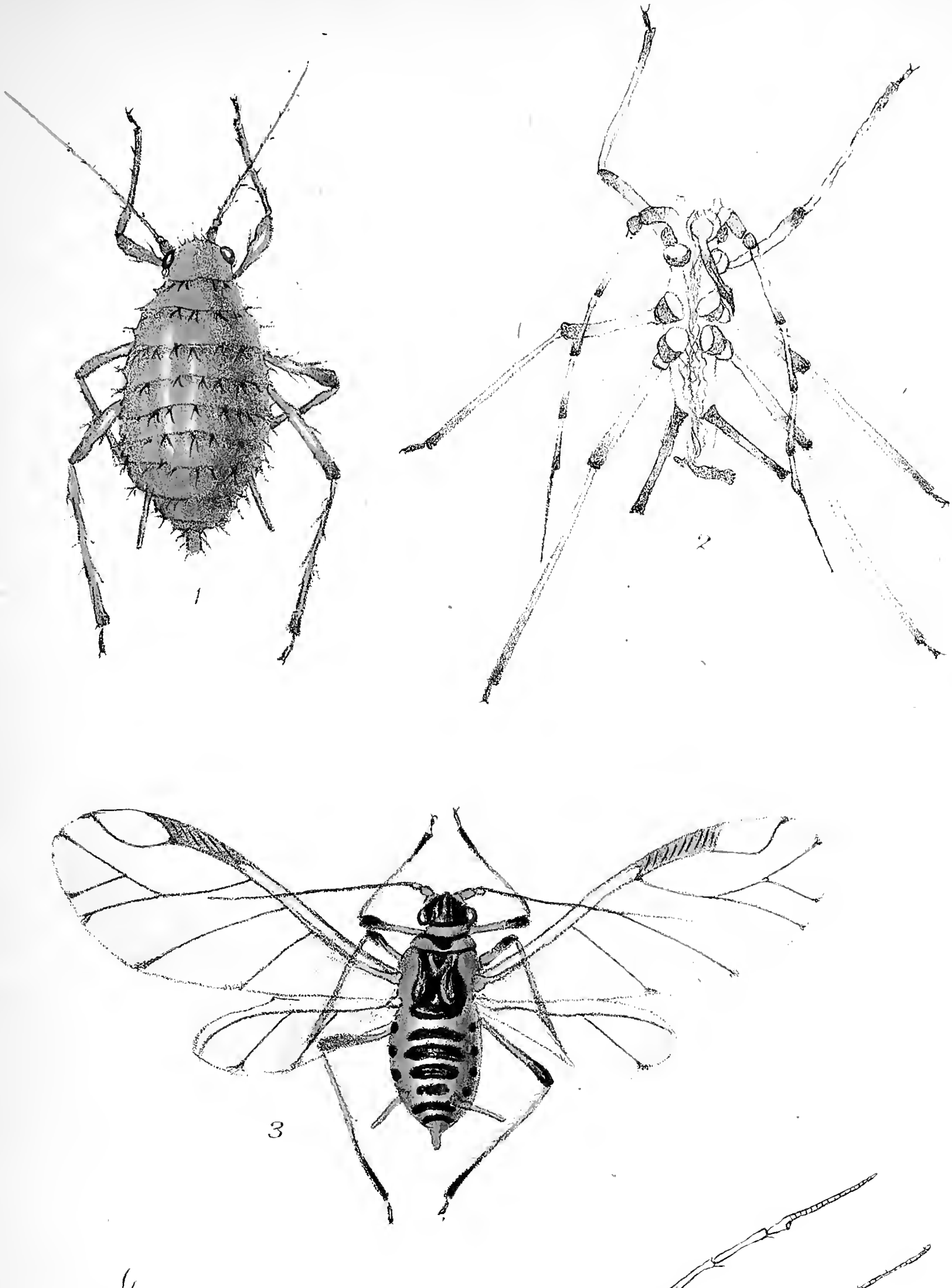
Siphonophora rosarum. (Page 150.)

Fig. 1.—Apterous viviparous female.

Fig. 2.—Slough or exuviæ, out of which the imago has emerged. The skin of the pupa is complete to the end of the antennal joints and to the tarsal claws. The skin is rent down the back and shrivelled into numerous folds. The coxæ and fulcra become very evident by their dark colour.

Fig. 3.—The winged viviparous female, showing the faint clouding of the wings at the extremities of the veins. *a.* Head of larval female. *b.* Head of imago, with the imbricated third antennal joint. *c.* Portion of the skin of the larva, showing the character of the capitate hairs, which are dilated into a kind of bladder at their tips.

PLATE XXII. bis



Siphonophora rosarum.

G. B. Buckton del. et lith.

W. West & Co. imp.

PLATE XXIII.

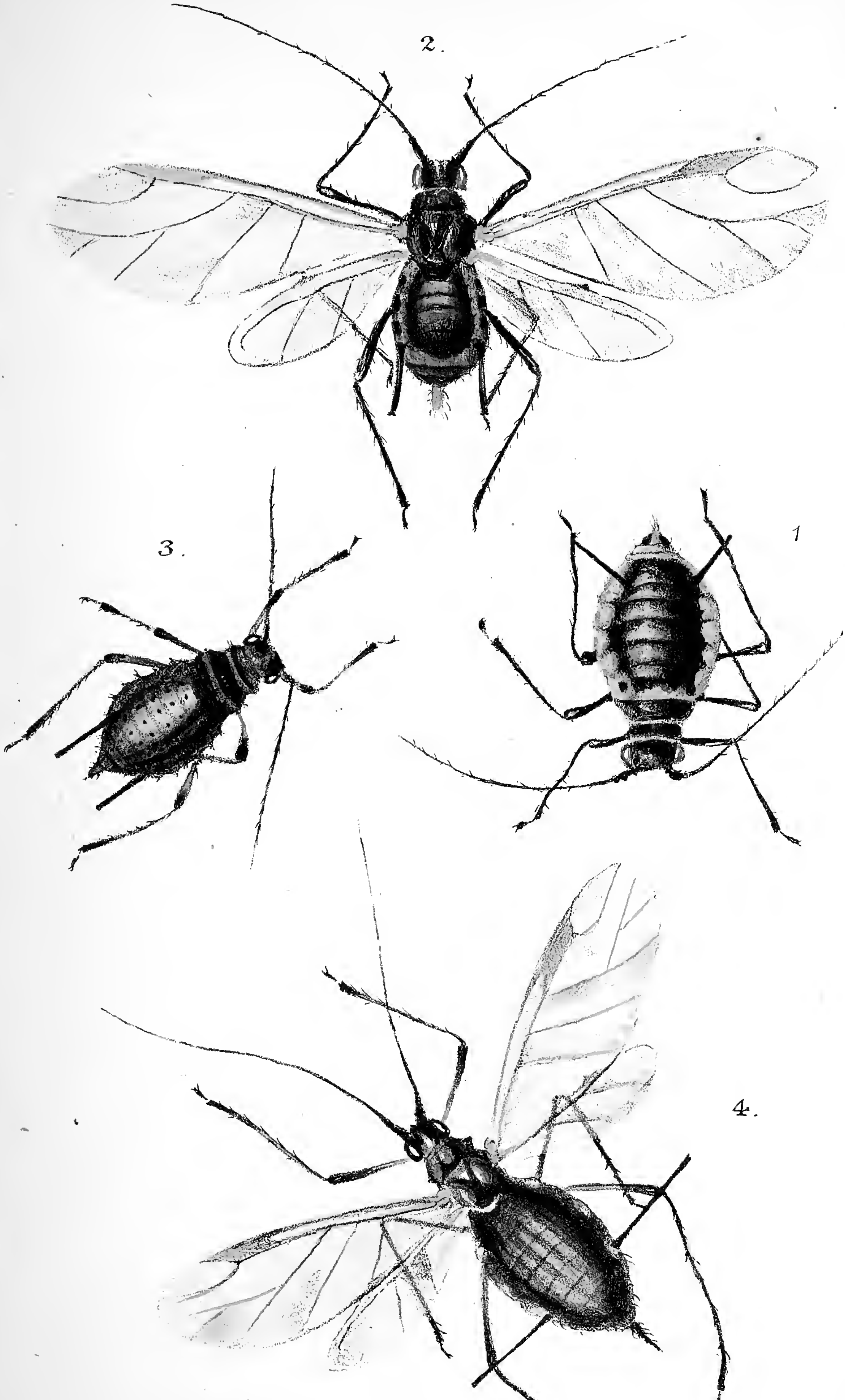
Siphonophora tanaceti. (Page 151.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Winged viviparous female.

Siphonophora jaceæ. (Page 153.)

Fig. 3—Apterous viviparous female.
Fig. 4.—Winged viviparous female.

PLATE XXIII.



1-2, Siphonophora tanaceti.
3-4, S. jaceæ.

G.B.Buckton del. et lith.

W. West & C° imp.

PLATE XXIV.

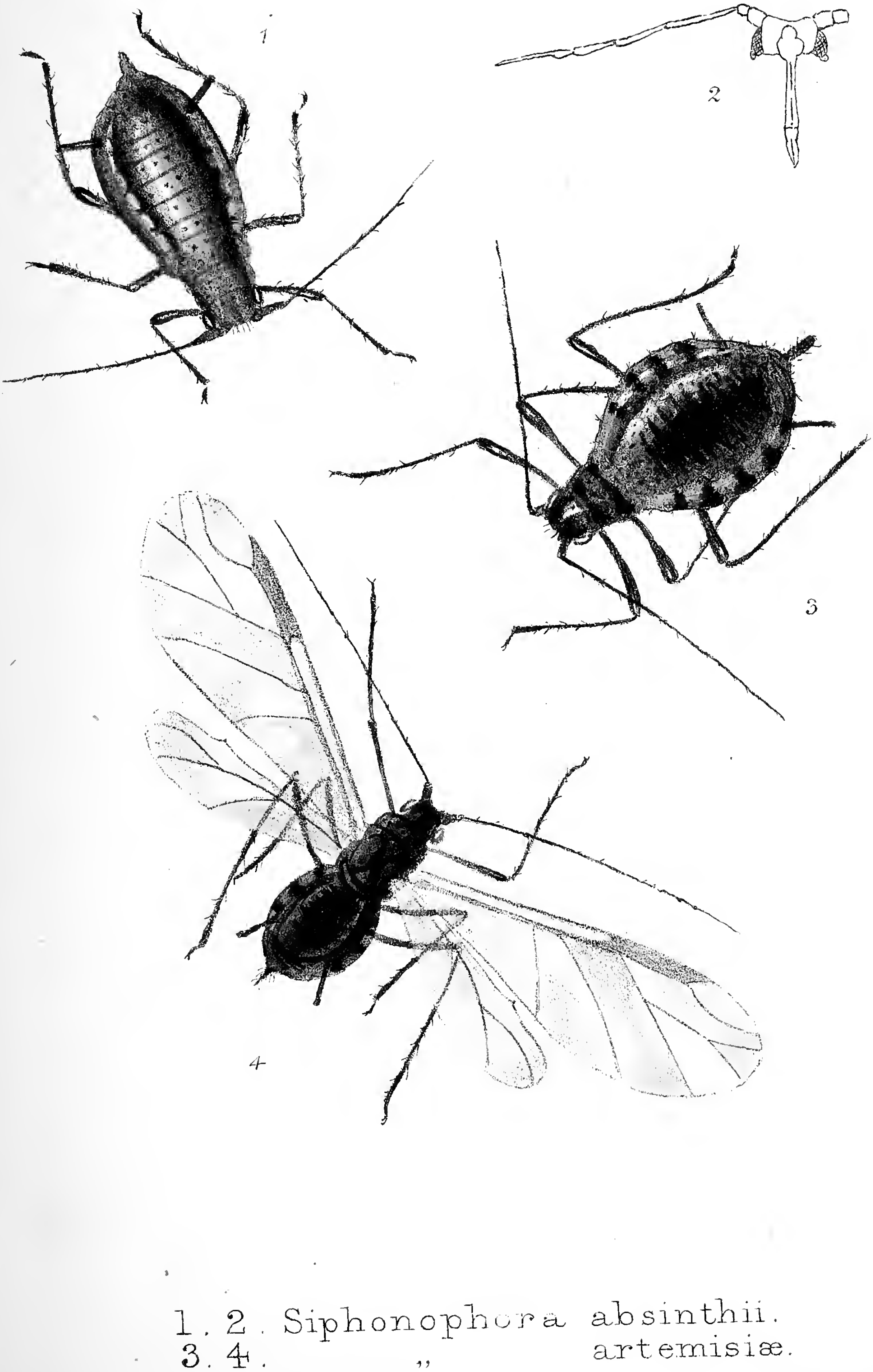
Siphonophora absinthii. (Page 154.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Head with antennæ and rostrum of the same.

Siphonophora artemisiæ. (Page 155.)

Fig. 3.—Apterous viviparous female.
Fig. 4.—Winged viviparous female.

PLATE XXIV.



1. 2. Siphonophora absinthii.
3. 4. " artemisiæ.

G.B.Buckton del. et lith.

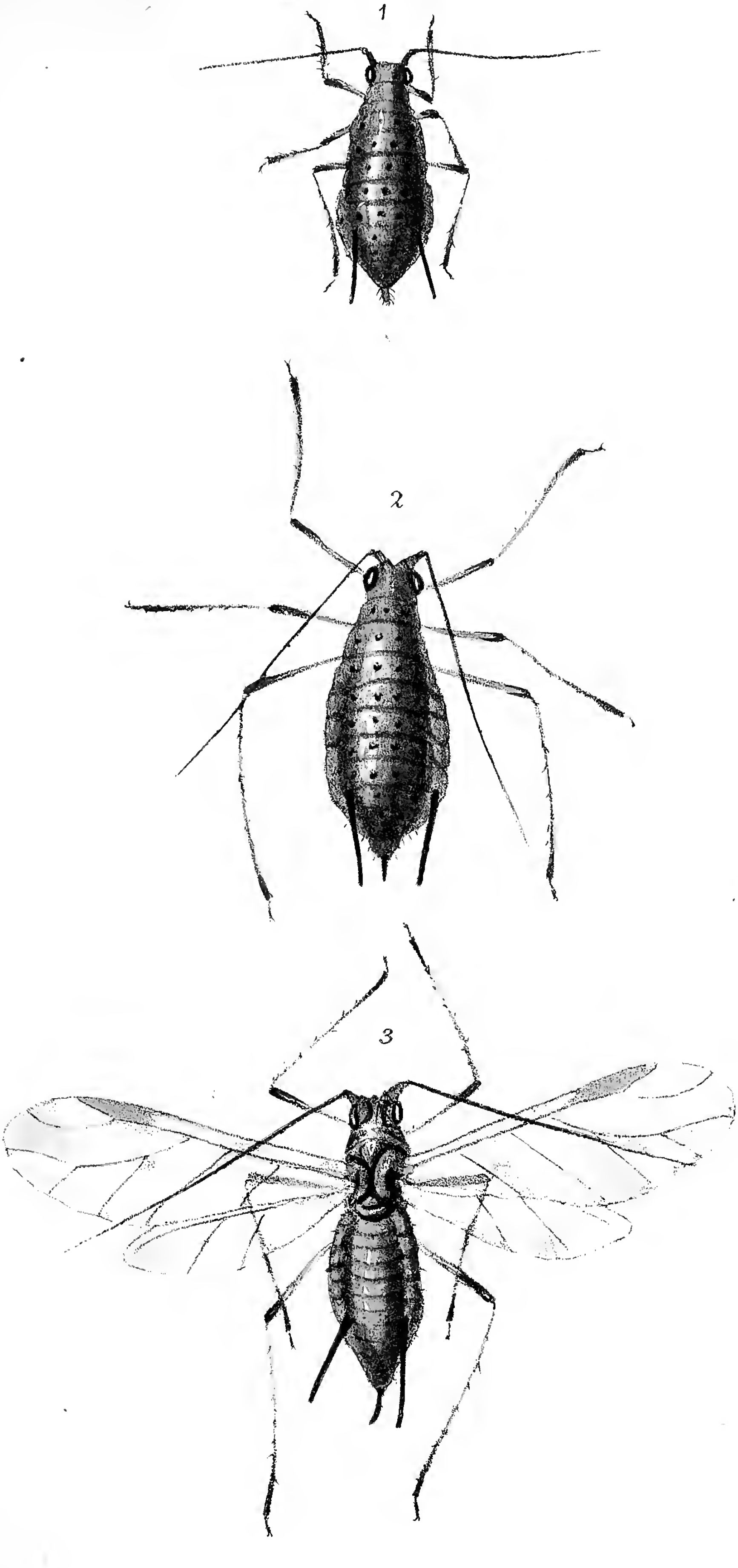
W. West & Comp.

PLATE XXV.

SIPHONOPHORA SOLIDAGINIS. (Page 156.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Variety of the same.
Fig. 3.—Winged viviparous female.

PLATE XXV.



Siphonophora solidaginis.

G.B.Buckton del. et lith. W. West & C^o imp

PLATE XXVI.

SIPHONOPHORA MURALIS. (Page 157.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Pupa.
Fig. 3.—Winged viviparous female.
Fig. 4.—Oviparous female.
Fig. 5.—Winged male. The perfect sexes are very much smaller than the imperfect viviparous forms. The male has remarkably large wings.
Fig. 6.—Head and antennæ of winged viviparous female.
Fig. 7.—Cauda of the same, with part of the anal plate.
Fig. 8.—Lower wing of the male insect.

PLATE XXVI.

Siphonophora muralis.

G. B. Buckton del. et lith.

W. West & Co. imp.

PLATE XXVII.

SIPHONOPHORA TANACETICOLA. (Page 159.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Pupa.

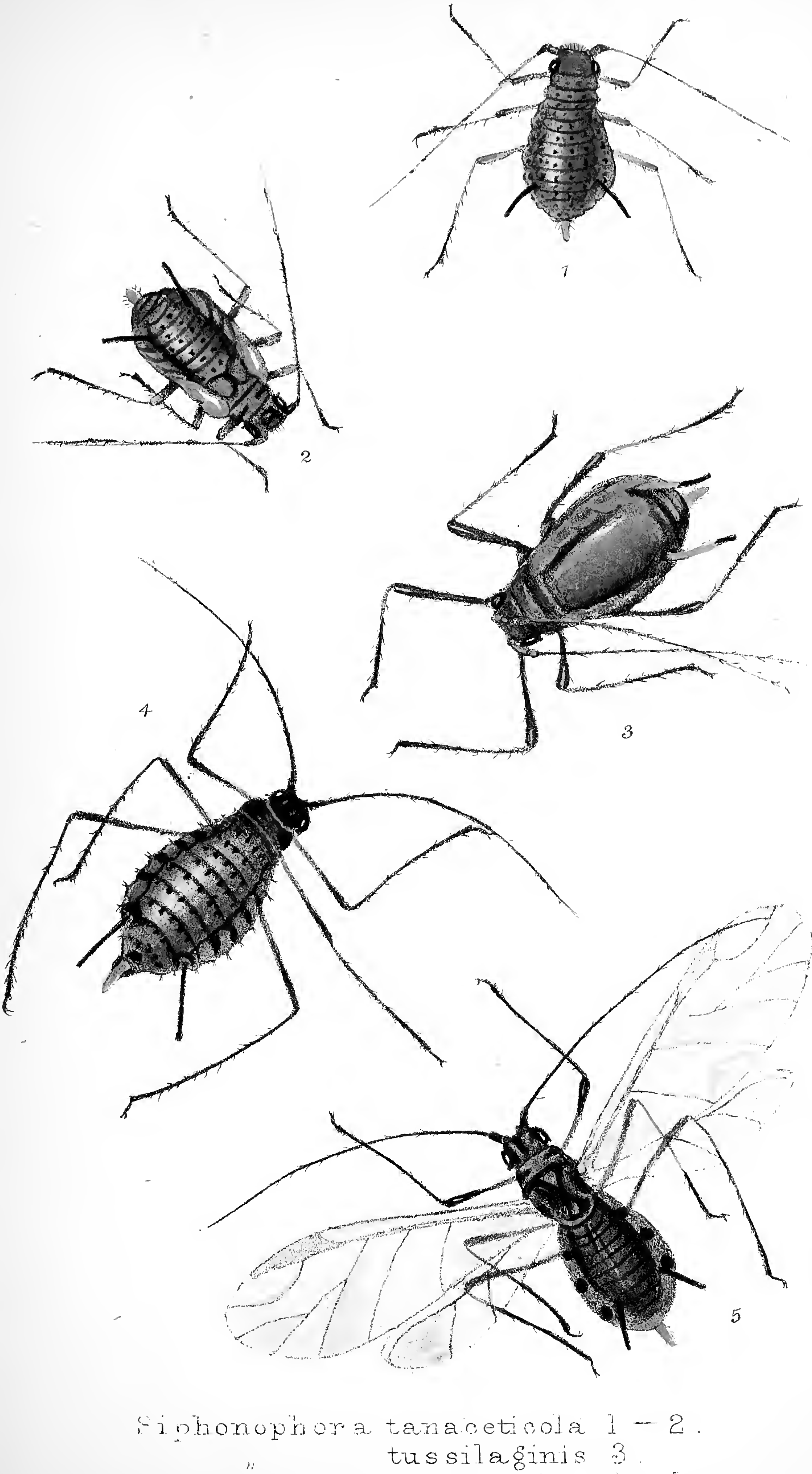
SIPHONOPHORA TUSSILAGINIS. (Page 159.)

Fig. 3.—Apterous viviparous female.

SIPHONOPHORA SISYMBRII. (Page 160.)

Fig. 4.—Apterous viviparous female.
Fig. 5.—Winged viviparous female.

PLATE XXVII.



Siphonophora tanaceticola 1 — 2.
" tussilaginis 3.
" sisymbrii 4 — 5.

G. B. Buckton del. et lith.

W. West & Co. imp.

PLATE XXVIII.

Siphonophora sonchi. (Page 161.)

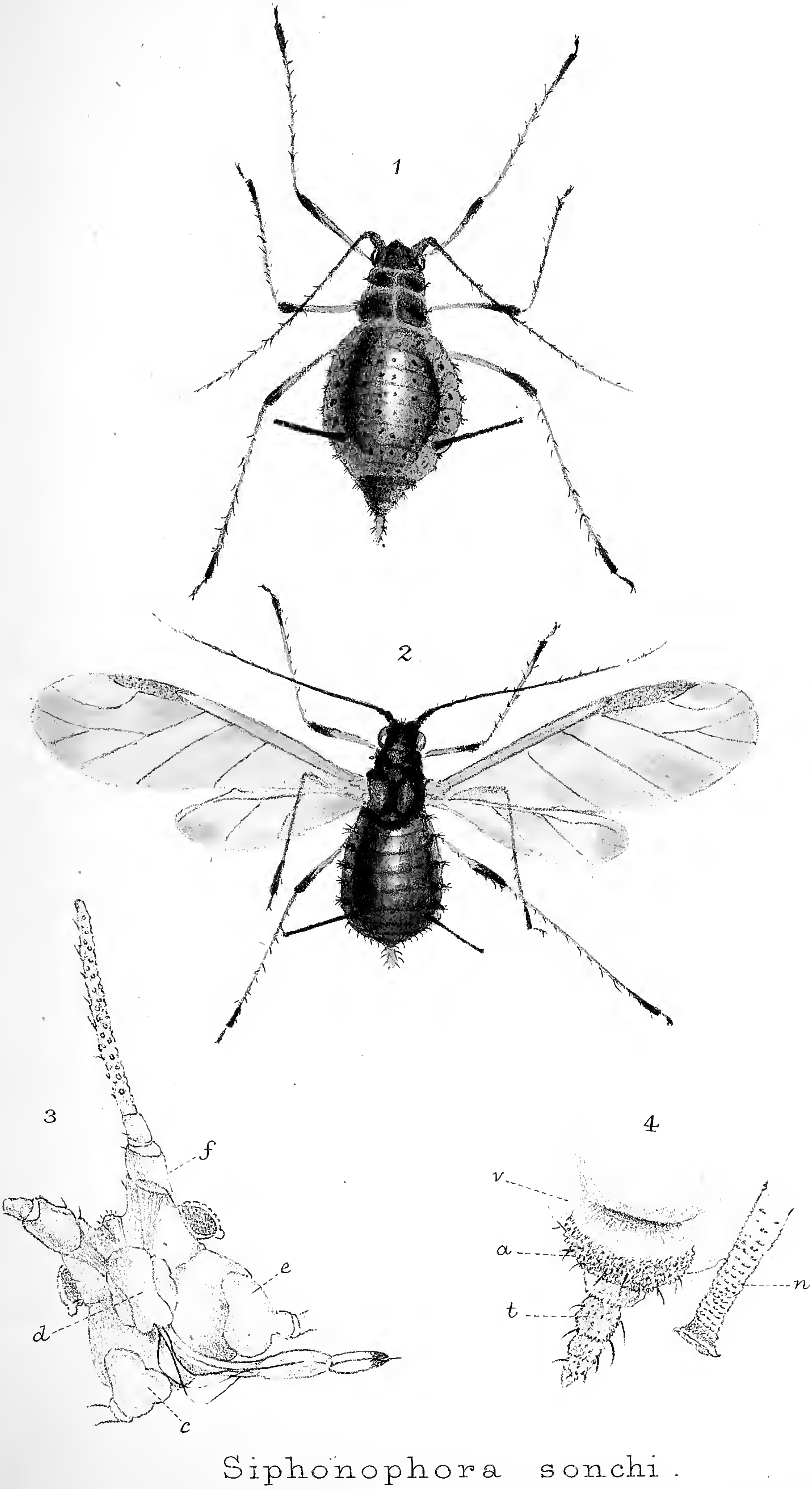
Fig. 1.—Apterous viviparous female.

Fig. 2.—Winged viviparous female.

Fig. 3.—Under side of the head of the last, showing the attachment of *d*, the clypeus, and the rostrum to the head and prothorax. The third antennæ joint is tuberculate. *f f*. The frontal tubercles. *c e*. Coxæ.

Fig. 4.—Under side of the last abdominal rings, showing, *t*, the rugose cauda. *a*. The anal plate. *v*. The vagina. *n*. The cornicle, the surface of which is imbricated and the mouth expanded. Through an error in the drawing the cornicle is represented in advance instead of behind the abdominal ring.

PLATE XXVIII.



Siphonophora sonchi.

G. B. Buckton del. et lith.

W. West & Co. imp.

PLATE XXIX.

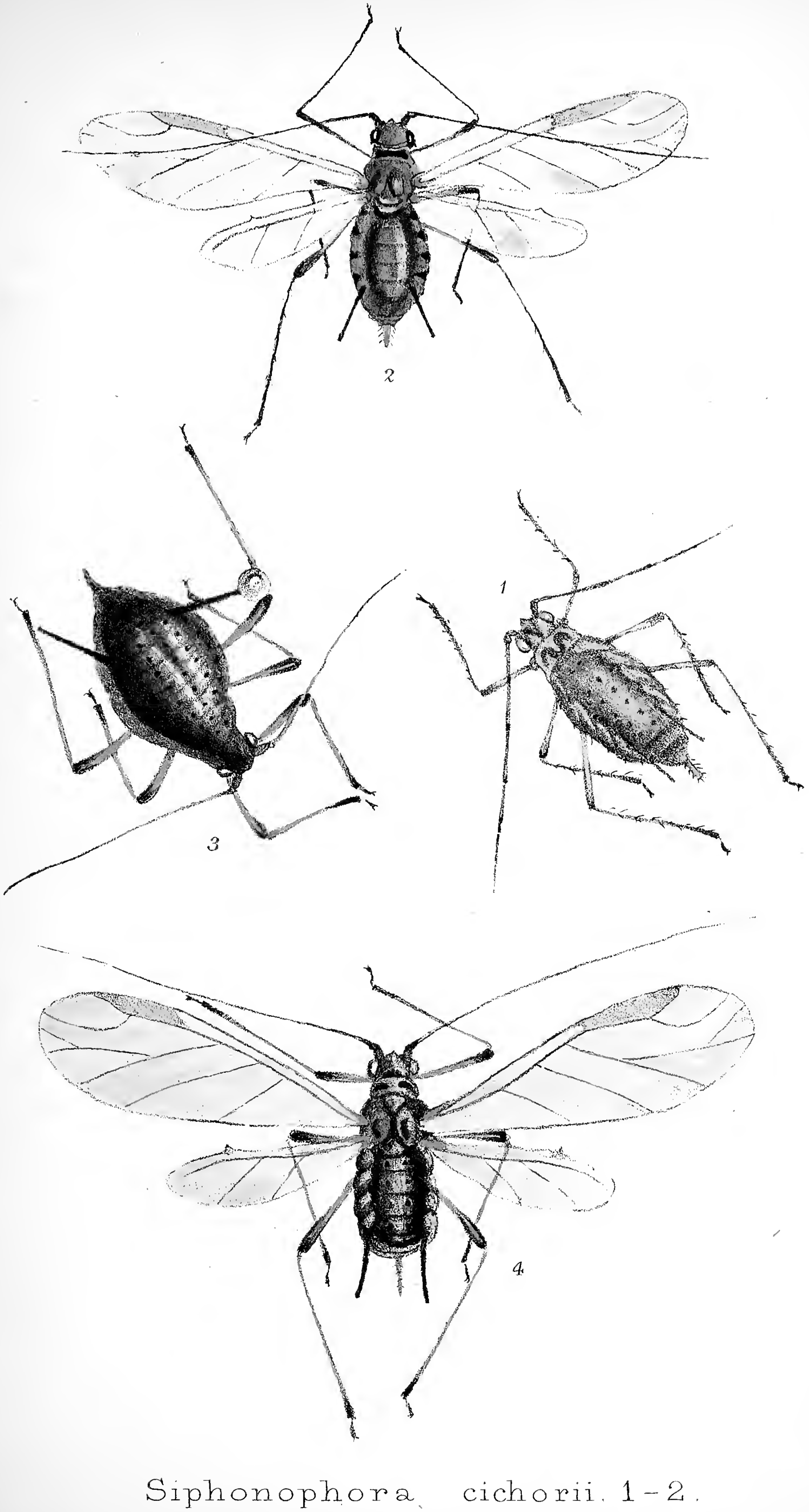
Siphonophora cichorii. (Page 163.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Winged viviparous female.

Siphonophora olivata. (Page 164.)

Fig. 3.—Apterous viviparous female.
Fig. 4.—Winged viviparous female. A globule of honey dew is shown at the apex of the cornicle, preparatory to its forcible ejaculation.

PLATE XXIX.



Siphonophora cichorii. 1 – 2.
S. olivata 3 – 4.

G.B.Buckton del. et lith.

W.West & Co. imp.

PLATE XXX.

PHORODON HUMULI. (Page 166.)

Fig. 1.—Apterous viviparous female.

Fig. 2.—Young pupa born from the last. The wing-cases are not yet developed.

Fig. 3.—Full-grown pupa. Numerous oil globules are seen in the neighbourhood of the nectaries.

Fig. 4.—Winged viviparous female, excluded from the pupa, fig. 3.

Fig. 5.—Winged male.

Fig. 6.—Head of the larva, showing the porrected frontal tubercles and the dentate or gibbous form of the first antenna joint.

Fig. 7.—The head of the winged female, in which the dentate characters are much modified.

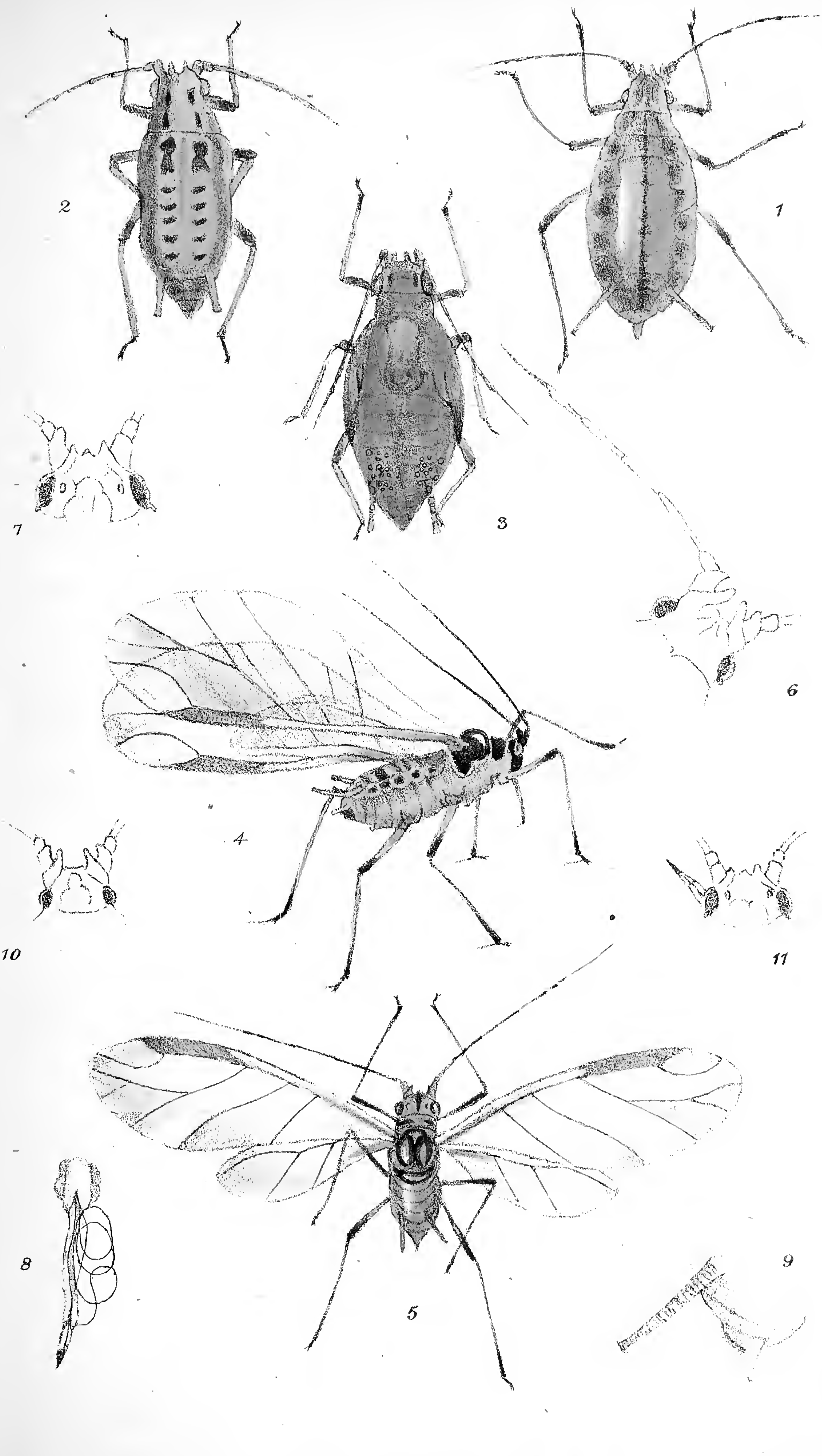
Fig. 8.—Rostrum and setæ of the male.

Fig. 9.—Cornicle and posterior abdominal rings of the same.

Fig. 10.—Head of the larva of *Phorodon malaheb.*

Fig. 11.—Head of the winged female of the same. These last figures are drawn for comparison with the same parts of *P. humuli.*

PLATE XXX.



Phorodon humuli.

G. B. Buckton del. et lith.

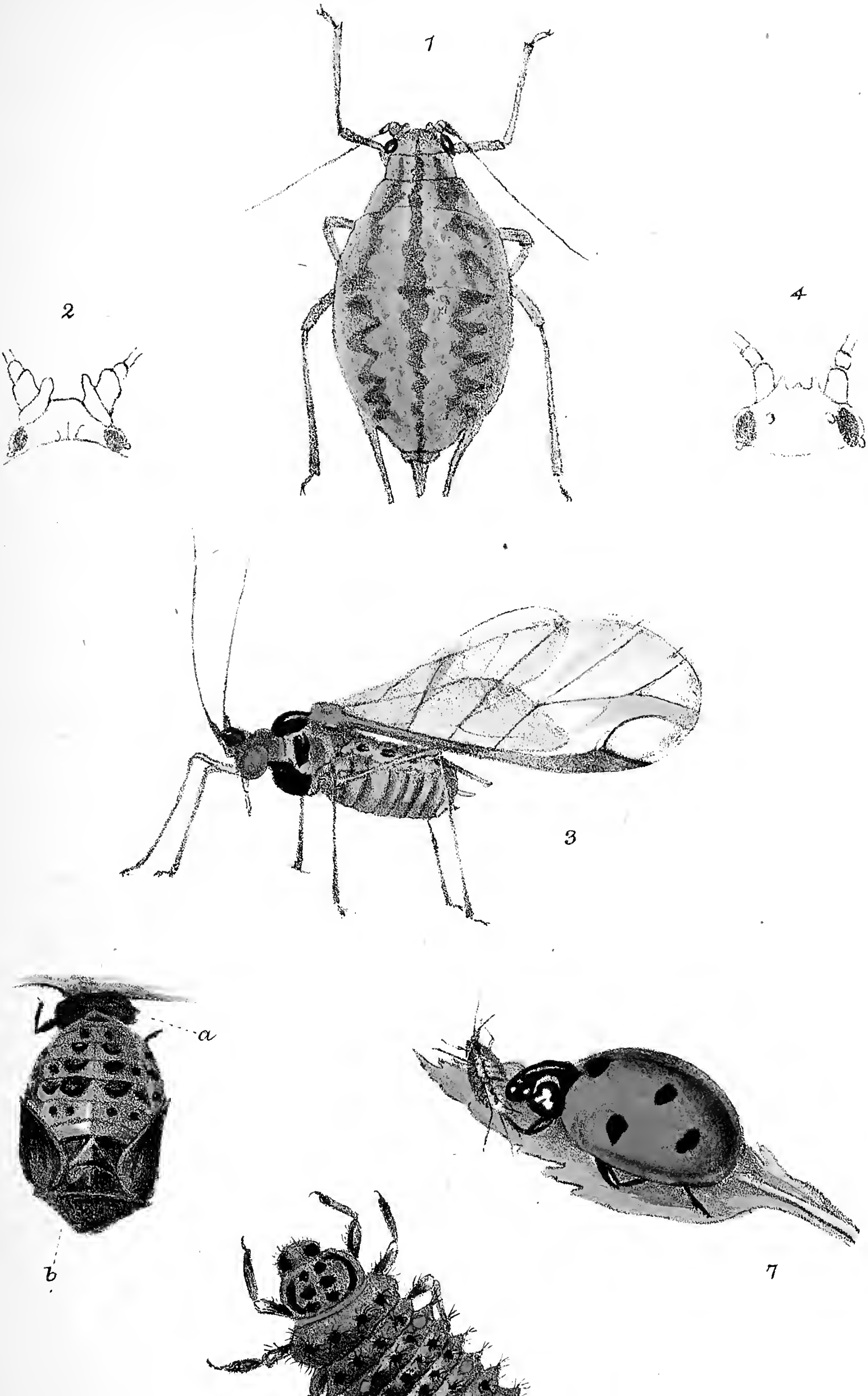
W. West & Co. imp.

PLATE XXXI.

PHORODON HUMULI, *var.* MALAHEB. (Page 168.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Head with the frontal tubercles and the two first antennæ joints.
Fig. 3.—Winged viviparous female.
Fig. 4.—Head of the same.
Fig. 5.—Larva of *Coccinella septem punctata*.
Fig. 6.—Hanging pupa of the same. *a*. Remnant of the larval skin which originally covered the pupa. *b*. Head and thorax.
Fig. 7.—Imago which has seized an Aphis.

PLATE XXXI.



G.B.Buckton del. et lith. W.West & Co. imp.

Phorodon humuli var: malaheb.
Coccinella septem-punctata .5–7.

PLATE XXXII.

Phorodon galeopsidis. (Page 171.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Pupa.
Fig. 3.—Winged viviparous female.
Fig. 4.—Pupa of the winged male.
Fig. 5.—Head and antennæ of the winged female.
Fig. 6.—Head and antennæ of the winged male.
Fig. 7.—Cornicle of the same.

N.B.—It will be seen that whilst the mouth parts of the males of the allied family Coccidæ generally appear to be suppressed, the same parts of the Aphididæ are fully developed.

PLATE XXXII.

Phorodon galeopsidis.

G. B. Buckton del et lith.

W. West & Co. imp.

PLATE XXXIII.

Mysus cerasi. (Page 174.)

Fig. 1.—Apterous viviparous female.
Fig. 2.—Pupa.
Fig. 3.—Winged viviparous female. *a*. Rostrum. *b*. Head and antennæ, the third joint is tuberculate.
Fig. 4.—Winged male.
Fig. 5.—Oviparous female.

PLATE XXXIII.

Myzus cerasi.

G.B.Buckton del. et lith.

W.West & Co. imp.

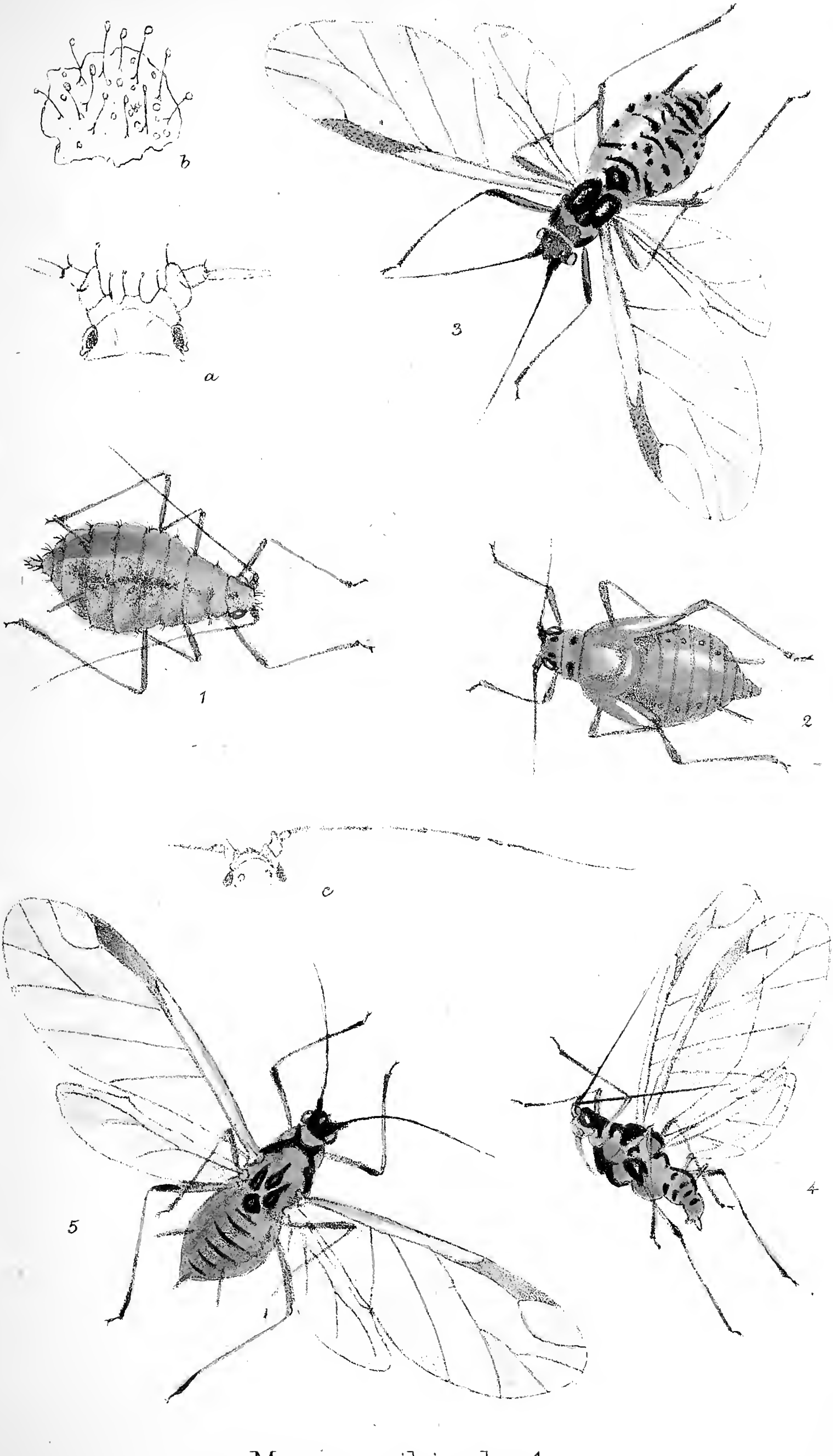
PLATE XXXIV.

MYZUS RIBIS. (Page 180.)

Fig. 1.—Apterous viviparous female. *a.* Head with frontal tubercles. *b.* Portion of skin clothed with capitate hairs.
Fig. 2.—Pupa of the male.
Fig. 3.—Winged viviparous female.
Fig. 4.—Winged male.

MYZUS GRACILIS. (Page 176.)

Fig. 5.—Winged viviparous female. *c.* Head and antennæ of the same.



Myzus ribis 1—4.
" gracilis 5.

G.B.Buckton del. et lith.

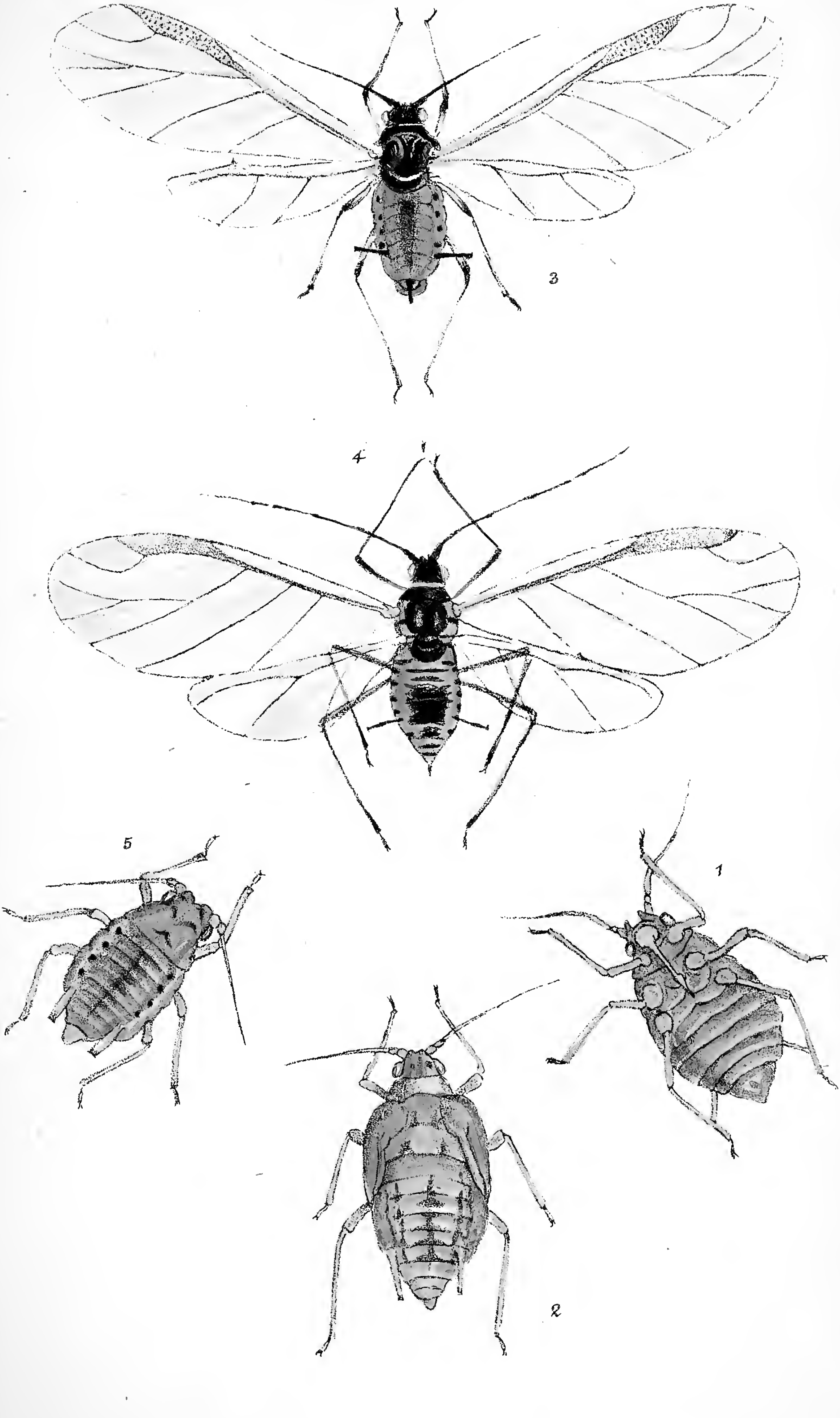
W.West & Co. imp.

PLATE XXXV.

MYZUS PERSICÆ. (Page 178.)

Fig. 1.—Under side of the apterous viviparous female.
Fig. 2.—Pupa.
Fig. 3.—Winged viviparous female.
Fig. 4.—Winged male.
Fig. 5.—Apterous oviparous female.

PLATE XXXV.



Myzus persicœ.

G.B.Buckton del. et lith.

W.West & Co imp.

PLATE XXXVI.

Drepanosiphum platanoides. (Page 183.)

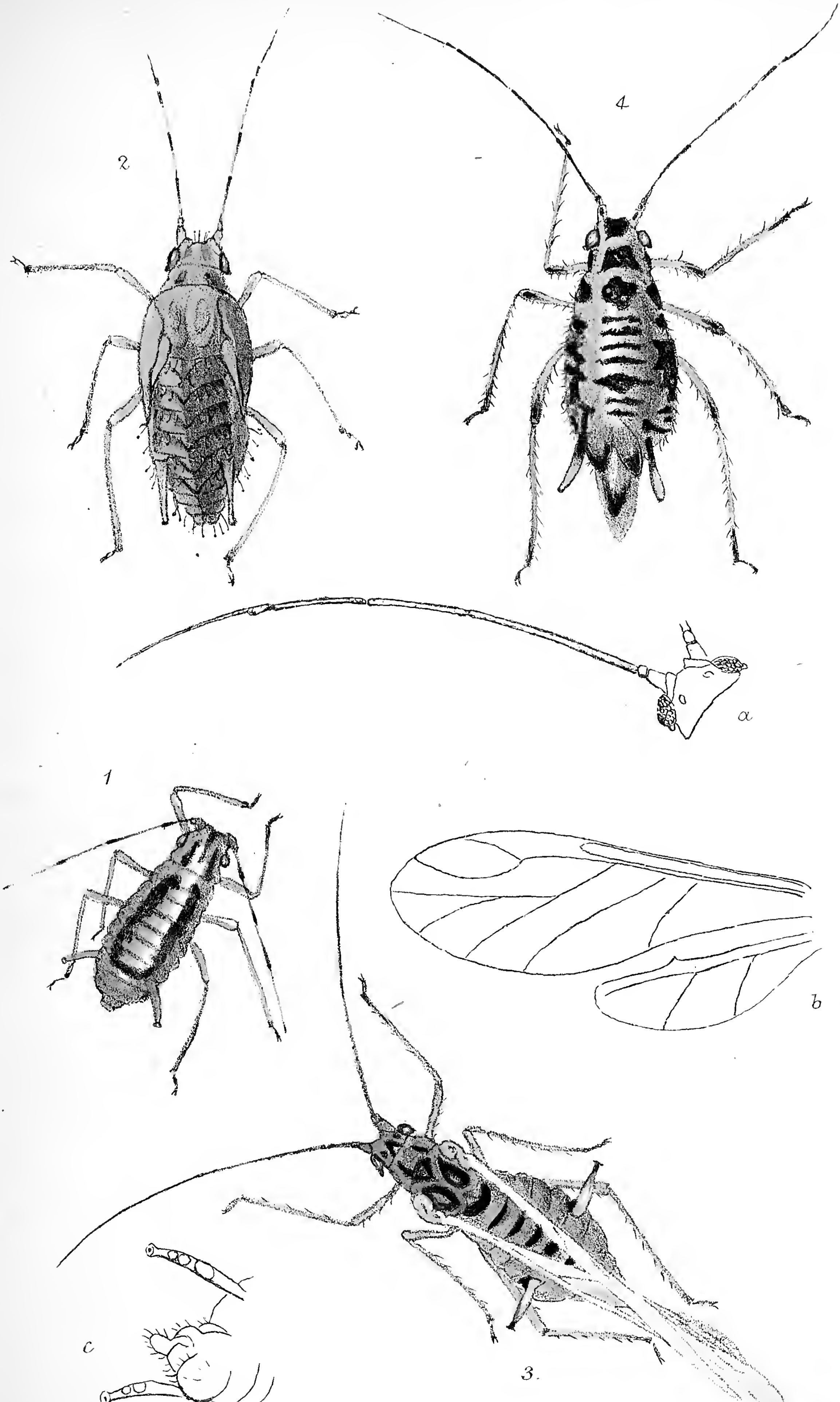
Fig. 1.—Immature form from which eventually the pupa is developed.

Fig. 2.—The pupa studded over with capitate hairs.

Fig. 3.—The winged viviparous female, which usually carries its cornicles at right angles to the medial line of the dorsum. *a.* Head and antennæ of the same. *b.* The upper and lower wings. *c.* The anal rings, the short tail, and the cornicles of the same.

Fig. 4.—The apterous oviparous female, showing the genital rings dilated into a sac or quasi ovipositor. The ova appear nearly ready for extrusion. The posterior ends have already commenced to change colour, thus indicating that they have been impregnated.

PLATE XXXVI.



Drepanosiphum platanoides.

G. B. Buckton del. et lith.

W. West & C° imp.

PLATE XXXVII.

Drepanosiphum acerina. (Page 185.)

Fig. 1.—The young Aphis drawn soon after birth.

Fig. 2.—The same several days older. As it contained no forward embryos, probably the pupa would have developed from it. The spots scattered over the body are due to numerous pink oil globules.

Fig. 3.—The winged viviparous female.

Amphorophora ampullata. (Page 187.)

Fig. 4.—The apterous viviparous female, showing the flasked-shaped cornicles and the embryos crowding the body, even into the cavity of the thorax.

PLATE XXXVII.

Drepanosiphum acerina 1-3.
Amphorophora ampullata 4.

G.B.Buckton del. et lith. W. West & Co imp.

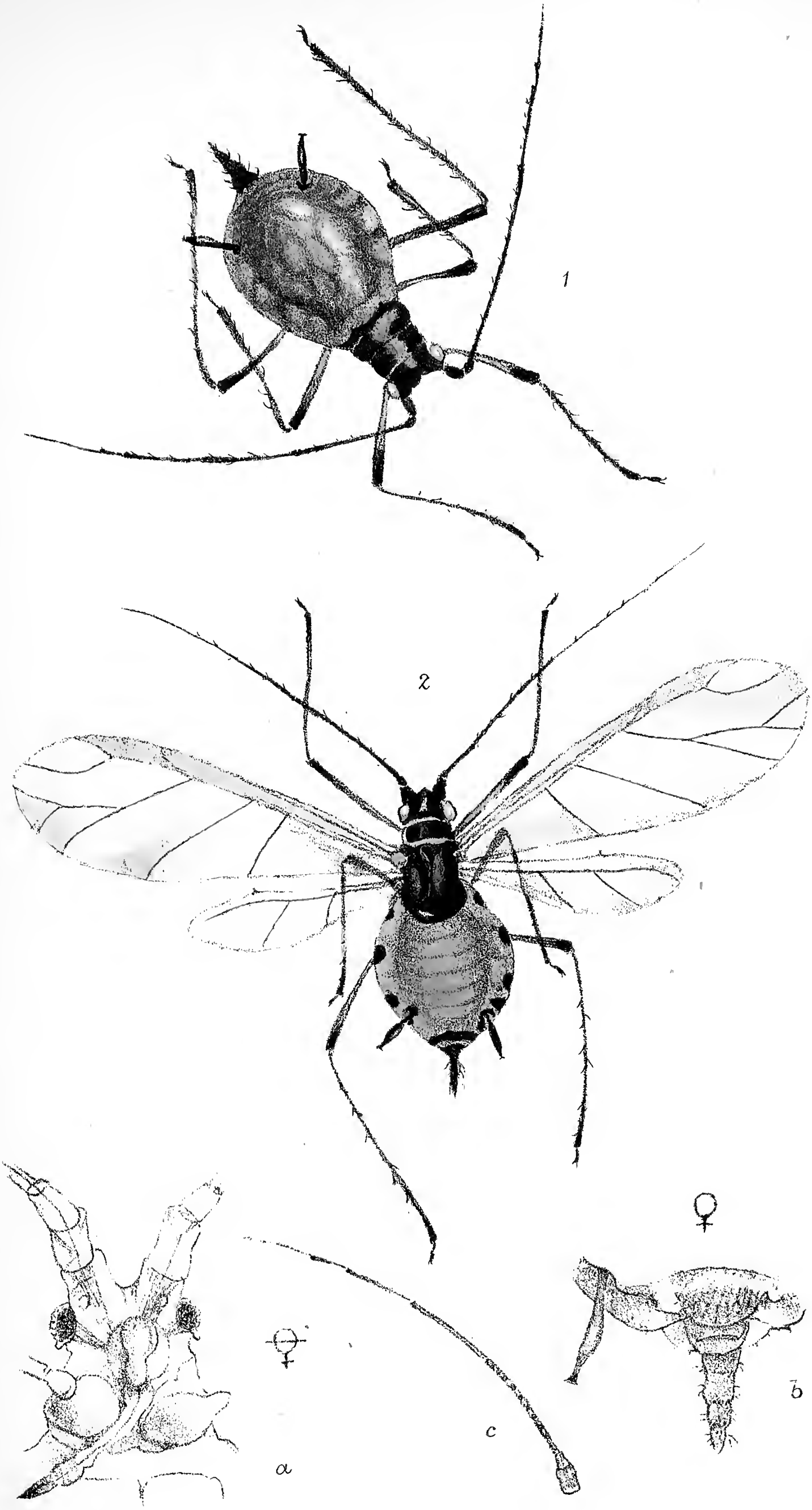
PLATE XXXVIII.

MEGOURA VICIÆ. (Page 188.)

Fig. 1.—Apterous viviparous female.

Fig. 2.—Winged viviparous female. *a.* Under side of the head, showing frontal tubercles and rostrum. *b.* End of the abdomen, with nectary and tail. *c.* Antenna of the winged female.

PLATE XXXVIII.



Megoura viciæ.

G. B. Buckton del. et lith.

W. West & Co. imp.